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Μεταπτυχιακή Διπλωματική Εργασία

THE INTEGRATION OF ENVIRONMENTAL RISKS INTO THE CREDIT RISK  
MANAGEMENT PROFILE OF EUROPEAN BANKS

Του

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OF EUROPEAN BANKS  
ZAVOS PANAGIOTIS ANDREAS

## Dedications

This thesis is dedicated to my parents, Christos and Dionysia, as well as my brother Alex, for their unwavering belief in me and my abilities, as well as their unending emotional, mental, and psychological support over the years.

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This thesis represents the end of a one and half year effort to acquire a deeper understanding of the financial and banking administration.

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## Περίληψη

### Η ΕΝΣΩΜΑΤΩΣΗ ΤΩΝ ΠΕΡΙΒΑΛΛΟΝΤΙΚΩΝ ΚΙΝΔΥΝΩΝ ΣΤΟ ΠΡΟΦΙΛ ΔΙΑΧΕΙΡΙΣΗΣ ΠΙΣΤΩΤΙΚΟΥ ΚΙΝΔΥΝΟΥ ΤΩΝ ΕΥΡΩΠΑΪΚΩΝ ΤΡΑΠΕΖΩΝ

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Τμήμα Τραπεζικής και Χρηματοοικονομικής Διοίκησης

Η πρόσφατη χρηματοπιστωτική κρίση, η οποία εκδηλώθηκε σε παγκόσμια κλίμακα κατά τη διάρκεια του 2007, ανάγκασε όλα τα χρηματοπιστωτικά ιδρύματα και τους επενδυτές να είναι πιο προσεκτικοί όσον αφορά τις πιστώσεις που παρέχουν και τη βιωσιμότητά τους. Η πρόβλεψη του πιστωτικού κινδύνου είναι ζωτικής σημασίας σε σχέση με τη βιωσιμότητα των τραπεζικών συστημάτων. Αυτό θα έχει ως αποτέλεσμα, αφενός, την προστασία των πιστωτικών ιδρυμάτων από λανθασμένες χρηματοδοτήσεις και, αφετέρου, την προστασία των επενδυτών από λανθασμένες επενδυτικές επιλογές. Επιπλέον, το θέμα των πράσινων δανείων έχει έρθει στο προσκήνιο τα τελευταία χρόνια, ως κρίσιμος παράγοντας για την επίτευξη των παγκόσμιων στόχων βιωσιμότητας που σχετίζονται με τη μείωση των εκπομπών CO<sub>2</sub>. Σκοπός της παρούσας διατριβής είναι να προσδιορίσει τη σημασία της ενσωμάτωσης του κινδύνου που προκύπτει από τα πράσινα δάνεια στο προφίλ διαχείρισης πιστωτικού κινδύνου των ευρωπαϊκών τραπεζών, μέσω της πρότασης ενός οικονομετρικού υποδείγματος που βασίζεται σε εμπειρική διερεύνηση, το οποίο επαληθεύτηκε με τη χρήση χρηματοοικονομικών δεδομένων των έξι μεγαλύτερων οικονομιών της Ε.Ε., προκειμένου να προβλεφθεί η βιωσιμότητα των τραπεζικών τους συστημάτων με τη μεγαλύτερη δυνατή ακρίβεια.

Λέξεις κλειδιά: Πιστωτικός κίνδυνος, πράσινα δάνεια, περιβαλλοντικός κίνδυνος, βιωσιμότητα τραπεζικού συστήματος, Ε.Ε. τραπεζικό σύστημα

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UNIVERSITY OF PIRAEUS

## Abstract

### THE INTEGRATION OF ENVIRONMENTAL RISKS INTO THE CREDIT RISK MANAGEMENT PROFILE OF EUROPEAN BANKS

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The recent financial crisis, which occurred on a global scale during 2007, forced all financial institutions and investors to be more careful about credits they provide and their viability. The prediction of credit risk is crucial in relation to the sustainability of banking systems. This will have the effect, on the one hand, of protecting credit institutions from incorrect financing and, on the other hand, of protecting investors from incorrect investment choices. Furthermore, the issue of green loans has come to the forefront during recent years, as a crucial factor towards the achievement of global sustainability objectives related to the reduction of CO<sub>2</sub> emissions. The purpose of the present thesis is to identify the significance of integrating the risk arising from green loans to the credit risk management profiles of European banks, through proposing an econometric model based on empirical investigation, which was verified using the financial data of the six largest economies of the E.U, in order to predict the viability of their banking systems under the most possible accuracy.

Keywords: Credit risk, green loans, environmental risk, banking system sustainability, E.U. banking system

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## Introduction

In recent decades, all financial institutions, worldwide, aware of the important developments in environmental issues and sustainable development, have proceeded with important revisions in the entire range of their operations. These rapid changes have also brought about changes in the way of financing new investments as the environmental legislations that have been passed in all developed and developing countries impose strict measures with heavy fines for the protection of the environment.

Banking institutions, although a little late, seem to have adapted to the new data in recent years and have begun to give special importance to green products for both individuals and businesses. At the same time, in the part of corporate social responsibility that concerns environmental policy, they have undertaken important environmental actions. Realizing the spirit of the times, banks create new innovative green products and services offered such as green insurance and studies for the installation of photovoltaic systems.

Following the adoption of the Paris Agreement on climate change and the UN's 2030 Agenda for Sustainable Development in 2015, governments are making major strides towards transitioning to more circular, low-carbon economies globally. On the European front, the European Green Deal sets the goal of making Europe the first climate-neutral continent by 2050. The financial sector is expected to play a key role in this, as foreseen in the Commission's action plan on financing sustainable development (ECB Financial Stability Review, May 2019).

The transition to a more circular, low-carbon economy entails both risks and opportunities for the economy and financial institutions, while natural disasters caused by climate change and environmental degradation can have a significant impact on the real economy and the financial system. The European Central Bank (ECB) has identified climate risks as a key risk factor for the euro area banking system. The ECB is of the view that institutions should adopt a forward-looking and integrated approach to addressing climate and environmental risks (ECB Financial Stability Review, May 2019).

The ECB is closely monitoring developments that may affect euro area institutions. The Commission's action plan on financing sustainable development aims to redirect financial flows towards sustainable investments, integrate the sustainability dimension into risk management and strengthen transparency and long-term planning. Specifically for the banking sector, the European Banking Authority (EBA) has been

given several mandates to assess how the risks related to the environment, social responsibility and governance (Environmental, Social and Governance - ESG) can be integrated into the three pillars of prudential supervision. Based on this, the EBA published an action plan on sustainable finance which addressed key policy messages to institutions in the areas of strategy and risk management, data disclosure, scenario analysis and stress testing exercises (ECB Financial Stability Review May, 2019).

As a first step, the ECB expects banks to have adequately categorized climate-related and environmental risks and to have completed a full assessment of the impact of these risks on their operations by March 2023 at the latest. In a second step, and at the latest by the end of 2023, the ECB expects banks to have climate-related and environmental risks integrated into their governance, strategy and risk management. In a final step, by the end of 2024 banks will have to meet all remaining supervisory expectations on climate-related and environmental risks outlined in the 2020 Directive. This includes the full integration of the Internal Capital Adequacy Assessment Process (ICAAP) and the stress testing process. The ECB warns banking institutions that it will closely monitor these deadlines and, if necessary, initiate enforcement measures (ECB Financial Stability Review May, 2019).

Banks have started to integrate environmental risks into their credit risk management procedures. This thesis will explore the analysis of the integration of environmental risks into all phases of the credit risk management, rating, costing, pricing, monitoring and work-out. The integration of environmental risks into the whole credit risk management process is important because only then is an adequate risk management guaranteed. The subject of this thesis is the interpretation of the concept of sustainable development, Corporate Social Responsibility and green banking with historical references. At the same time, the important role that the banking system must play in promoting sustainable development will be examined.

In particular, the first chapter will set out the theoretical framework, with reference to bank and environmental risk, types of risk, systematic risk, non-systematic risk, the concept of sustainable development, corporate social responsibility. The second chapter refers to the regulatory framework for financial institutions – Basel Committee, the forms of operational risk, the benefits of green banking, retail banking, the prospects and future developments of green banking. While the third chapter lists the methodology to be used, with its succession from the fourth chapter, in which the results will be presented.

## 1. General Theoretical Framework

### 1.1. The risk: bank and environment

Green banking takes proactive measures to protect the environment and address climate change while financing alongside the efficient use of renewable, non-renewable, human and natural resources. Some important characteristics of green banking are summarized as follows (Lalon, 2005):

- Banks can help the environment through automation and online banking,
- Green banking focuses on social protection and safety through changing the negative impacts of society,
- Funding always prioritizes investments/loans that address risk factors for environmental conditions,
- A pleasant atmosphere is created inside and outside the bank,
- Sustainable and green growth in industry and for social purposes is always taken care of,
- Bank customers are considered family members, and banks guide and supervise programs to reduce pollution,
- Costs and energy are reduced thus saving money and increasing the country's GDP. It should not be ignored that an important part of green banking is also green finance, which has been developed to improve sustainable development and promote economic development in the financial sector.

More specifically, green finance refers to a variety of financial services and products provided by financial institutions for sustainable development. Although there is still no consensus on the definition of green economics, some key elements have been widely accepted.

According to earlier studies, green finance, in the context of the banking sector, includes a wide spectrum of the market based on business lending or investment, with the participation of retail banking, project financing, asset management, types of loans and investment financing (Baiaetal, 2014).

Also, in the banking industry, green finance means that the banking industry should not only contribute to reducing the environmental impact of finance, but should proactively finance green businesses and technologies, develop new green financial products and contribute to further development of the low carbon market (Baiaetal., 2014).

Therefore, the time has come for banks to adopt a comprehensive green banking policy in a formal and structured way, according to global standards in order to protect

the environment from degradation and ensure sustainable banking practices (Lalon, 2015).

The reasons for adopting green strategies are multiple, for example, increasing energy consumption as well as energy prices, increasing consumer interest in environmentally friendly goods and services, higher public expectations of banks' environmental responsibilities and the emerging stricter regulatory requirements (Sharmaetal., 2013).

In general, conventional banks rely on safety and efficiency, and are therefore reluctant to extend the scope of their external ethical rules. However, the above has changed due to the international propaganda for green banking activities. The issues of sustainable development, sustainable banking, sustainable businesses and sustainable societies are high on the agenda in many developing and industrialized countries.

The role of businesses and banks has been given a distinct place, like that of governments, in promoting human and economic development in such a way that it is sustainable. There is now greater scrutiny of the business operations and corporate governance practices of businesses and banks around the world (Tseleetal., 2007).

The recent banking crises have led financial and banking experts as well as scholars to think of innovative banking practices in order for banks to come out of the economic and financial problems they are experiencing. It therefore becomes obvious to banking experts that solutions should not focus only on simply improving supervision and regulation.

As an alternative, experts support the need to change the current economy, where the only motivation is maximum profit in an economy where everyone contributes to achieve banking sustainability. Again, the concept of a "sustainable" bank is starting to grow. The exact concept of a "sustainable bank" has evolved over time and is still a matter of debate (Rebaietal., 2012).

One of the reasons that green banking has grown significantly in recent years is because it minimizes the risks associated with the banking sector. More specifically, these risks can be credit, legal and reputational risks, which are analyzed below. So the importance of green banking is huge both for the banks themselves and for the economy as a whole.

In particular, banks have to manage credit, legal risk, reputational risk, effective management of these risks is critical to the performance of financial institutions. For each of these areas, they are implementing a series of measures to better address them.

Credit Risk: Can arise indirectly, when banks lend to their customers whose activities are adversely affected by the costs of dealing with pollution or due to changes in environmental regulations. The cost of meeting the new requirements on emission levels may be significant enough to put some companies out of business.

Credit risks may be greater due to the possibility of customer defaults as a result of incalculable costs for capital investments, production facilities, loss of market share and third-party liability claims. In addition, the risk of borrowers being unable to repay the loan is greater due to their environmental obligations, due to fines, legal liabilities and due to the reduced priority of repayment when they are in bankruptcy. Finally, credit risks are associated with lending on the security of properties whose value has decreased due to environmental problems (Sahoo & Nayak, 2007).

Legal Risk: Banks, like other companies, are at risk if they themselves do not comply with relevant environmental legislation. They are also at risk of direct lender liability for cleanup costs or compensation claims if they own "contaminated" assets that cause pollution. An environmental management system helps a bank to reduce its risks and costs, enhance its image and finally take advantage of revenue generation opportunities (Sahoo & Nayak, 2007).

Reputational Risk: Probably due to the growing awareness of environmental issues, banking institutions are more prone to losing their reputation if they are involved in large projects, which are perceived as socially and environmentally damaging. There are also cases where environmental management systems have led to cost savings, reduced risk, greater environmental stewardship, increased operating profits and increased bond values. Finally, reputational risk is considerable when banks are involved in financing ecologically and ethically questionable projects (Heim & Zenklusen, 2005).

In conclusion, the adoption of green banking strategies will help the bank to deal with these risks, which are associated with their activities. The main issues that must be taken into account by anyone who aims to develop green banking products are (Eellsetal., 1966):

- The existing green products offered today by the various financial institutions in the world.
- Market trends for the development and promotion of green products.
- The guidelines and legislation that support the development of green products.
- The current need for green products and how it will be shaped in the future.
- Good practices and experience gained during the development of such products.

- The basic elements that financial institutions need to know in relation to the development and marketing of these products.

All these six points are very important to analyze in depth in order to have a complete picture of what is happening around green banking products and how important the banking industry is playing by choosing to create products that address exclusively to those who want to invest in green growth.

For this reason, an analysis will be made of the green banking products that exist around the world, but also to present their main categories that are not only related to banking products, but also to other forms. These are (Evangelinos et al., 2009):

1. products with the aim of promoting large-scale environmental protection (e.g., buying and selling pollutants, RES loans).
2. optimization products, in order to promote green investments (e.g., creating a portfolio of green customers, loans for the purchase of environmental cars).
3. environmental stock market indices and sustainability indices, which aim to evaluate companies for their environmental and social behavior.

These indicators allow investors to consider environmental criteria in their business choices. Based on these categories and the type of customer, different departments within financial institutions around the world develop such products.

## 1.2. The Species of Danger

Risk involves the extent to which any action or inaction is chosen that may lead to loss or some undesirable outcome. The concept suggests that a choice can have an influence on the outcome that exists or has existed. However, in terms of financial management, risk is related to any material damage associated with the project, which may affect productivity, ownership, legal issues, etc.

### 1.2.1. Systematic risk

Systematic risk is due to the effect of external factors on an organization. These factors are usually uncontrollable from an organization's point of view. It is macro-economic in nature as it affects a large number of organizations operating under similar direction or same sector. It cannot be programmed by the organization. The types of systematic risk are listed below (Power, 2007):

- Interest rate risk.
- Market risk.
- Purchasing power or inflationary risk.

#### - Interest rate risk

Interest rate risk arises due to the fluctuation of interest rates from year to year. It particularly affects debt securities as they carry the fixed interest rate. The types of interest rate risk are listed below (Power, 2007):

- Price risk.
- Reinvestment rate risk.

The concept of price and reinvestment risk is as follows:

Price risk arises due to the possibility that the price of stocks, commodity, investments, etc. may fall or fall in the future.

Reinvestment risk arises from the fact that the interest or dividend earned on an investment cannot be reinvested at the same rate of return it earned earlier.

#### - Market risk

Market risk is associated with continuous fluctuations observed in the trading price of any particular stock or security. That is, it is due to the rise or fall in the trading price of listed shares or securities on the stock exchange.

The types of market risk are listed below (Power, 2007):

- Absolute risk.
- Relative risk.
- Directional risk.
- Non-directional risk.
- Basic risk.
- Volatility risk.

The meaning of the different types of market risk is as follows: Absolute risk is without content. For example, if he flips a coin, there is a fifty percent chance of getting letters and vice versa.

Relative risk is the assessment or evaluation of risk at various levels of business operations. For example, a relative risk from exchange rate fluctuation may be higher if the maximum sales attributable to an organization are export sales.

Directional risks are those risks where the loss results from exposure to the specific assets of a market. For example, an investor who owns some shares shows a loss when the purchase price of those shares' decreases.

Non-directional risk occurs when the trading method is not consistently followed by the trader. For example, the dealer will buy and sell the share at the same time to mitigate the risk.

Basis risk is due to the potential for loss arising from imperfect risks. For example, the risks that constitute hedging positions in two related but not identical markets.

Volatility risk is a change in the price of securities as a result of changes in the volatility of a risk factor. For example, it applies to portfolios of derivative instruments, where the volatility of the underlying is a significant price influence. Purchasing power or inflationary risk.

Purchasing power risk is also known as inflation risk. It is so, since it originates (arises) from the fact that it negatively affects purchasing power. It is not desirable to invest in securities during an inflationary period.

The types of inflation risk are listed below (Power, 2007):

- ❖ The risk of demand inflation.
- ❖ The risk of cost inflation.

The concept of demand and cost inflation risk is as follows:

The risk of demand-side inflation is due to the increase in price, which is due to excess demand over supply. It occurs when supply does not meet demand and therefore can no longer be expanded. In other words, demand-side inflation occurs when the factors of production are under maximum utilization. The risk of cost inflation arises due to the continuous increase in the prices of goods and services. This is actually caused by higher production costs. A high cost of production inflates the final price of finished products that people consume (Power, 2007).



## 1.2.2. Non-Systemic Risk

Non-systemic risk is due to the effect of internal factors prevailing in an organization. These factors are normally controlled from an organization's perspective. They are microeconomic as they only affect a specific organization. They can be planned so that organizations can take the necessary actions to mitigate (reduce the effect of) the risk.

The types of unsystematic risk are listed below (Hutter & Power, 2005):

- ❖ Business risk or liquidity risk.
- ❖ The financial or credit risk.
- ❖ The operational risk.

Business risk or liquidity risk

Business risk is also known as liquidity risk. It is so since it originates (arises) from the sale and purchase of securities affected by business cycles, technological changes, etc.

The types of business risks or liquidity risk are listed below (Hutter & Power, 2005):

- ❖ Asset liquidity risk.
- ❖ Liquidity risk financing.

The concept of asset and funding liquidity risk is as follows:

Asset liquidity risk is due to losses arising from the inability to sell or freeze assets at or near their book value when required. For example, assets that are sold at a price lower than their book value. Funding liquidity risk exists because it does not have access to sufficient funds to pay on time. For example, when commitments made to customers, as stated in SLAs (service level agreements), are not met (Hutter & Power, 2005).

Financial or credit risk

Financial risk is also known as credit risk. It arises due to a change in the capital structure of the organization. The capital structure mainly consists of three ways in which the funds for the projects are sourced.

These are the following (Hutter & Power, 2005):

- ❖ Available funds (share capital).
- ❖ Lending of funds (loans).
- ❖ Retained earnings (reserve and surplus). The types of financial or credit risk are listed below.

- ❖ The exchange rate risk.
- ❖ The recovery rate risk.
- ❖ The risk of credit events.
- ❖ The non-directional risk.
- ❖ The dominant risk.
- ❖ Settlement risk.

The meaning of the types of financial or credit risk is as follows:

Currency risk is also called exposure rate risk. It is a form of financial risk arising from a possible change in the exchange rate of one country's currency against another country's currency and vice versa. For example, investors or businesses face this either when they have assets or businesses across national borders or have loans in foreign currency.

Recovery rate risk is an often-neglected aspect of credit risk analysis. The rate of recovery is usually necessary to evaluate. For example, the expected rate of recovery of funds offered (given) as loan to customers by banks, non-banking financial companies (NBFCs) etc.

The dominant risk is associated with the government. Here, a government is unable to meet its loan obligations, renege (to break a promise) on loans it guarantees, etc.

Settlement risk exists when the counterparty fails to deliver a security or its cash value in accordance with the trade or business agreement.

#### Operational risk

Operational risks are business risks that fail due to human error. This risk varies from industry to industry. It occurs due to anomalies in internal processes, people, policies and systems.

The types of operational risk are listed below:

- ❖ Model risk.
- ❖ The human risk.
- ❖ The legal risk.
- ❖ The political risk.

The meaning of the types of operational risk is as follows: Model risk is involved in the use of various models for the valuation of financial securities. This is due to the potential for loss arising from weaknesses in the financial model used to assess and manage a risk.

Human risk arises when people do not follow the organization's procedures, practices and/or rules. That is, they deviate from their expected behavior. Legal risk arises when the parties are not legally competent to enter into an agreement with each other.

In addition, this is related to regulatory risk, where a transaction may conflict with a government policy, or a specific legislation (law) may be amended in the future with retroactive effect. Political risk is due to changes in government policies. Such changes may adversely affect an investor. It is particularly widespread in third world countries.

### 1.3. Concept of sustainable development

In recent years, more and more people have been concerned with the approach to sustainable development. The political and business world give special importance to the 3 P's, that is, People, Planet and Profit, realizing that their business activities have a significant impact not only on the economy but also on the environment and society. More specifically, the 3 Ps are analyzed as follows (Jeucken, 2001):

a) People (social value): i.e., the value and development of employees, customers, suppliers and non-governmental organizations (NGOs) in a socio-economic context.

b) The planet (ecological value): i.e., a stable level of use of natural resources and burden on the environment, now and in the future, locally and globally.

c) The profit (economic value): that is, the level of profit necessary to ensure the continuity of the provision of services by the organization.

The business world therefore does not remain uninvolved in what is going on, taking into account all three of the above components of sustainable development in order to shape a sustainable future for societies (Kolk&Tulder, 2009).

Sustainable or sustainable development aims to create a society in which there will be no reckless use of natural resources. This pro-environmental approach aims to meet the needs of the present without, however, risking future generations meeting their future needs.

All this has been adopted in European policies, as non-governmental organizations (NGOs) push for an environmental strategy that will contribute to employment and the creation of new jobs. The environment and the economy are two closely related concepts that can no longer be considered in isolation. Each country's government has an important role to play in this by using various instruments to internalize environmental impacts into market prices.

Obviously, more sustainable consumer purchasing behavior will encourage businesses to make decisions about more sustainable production. In addition to this push (government) and pull (consumer) factors, businesses can also promote more sustainable development themselves because they may have their own ideological concerns or business reasons for which they strive for sustainability (Wayne, 2010).

Today's reality therefore requires companies to try to reduce their operating costs, maximize the yield of raw materials, take actions to control or limit their waste as much as possible, not make unnecessary use of energy resources and finally create environmentally friendly products. The previous ones are carried out in the context of the new environmental reality so that they also contribute significantly to the sustainable development and preservation of the natural environment in which they operate (Stefanescu et al., 2012).

Going further, it is established that the objective of the business should not be only its economic growth, but the creation of value not only for the shareholders but also for the wider society. Its actions should be aimed at adopting good business practices, enhancing its corporate reputation, building strong relationships with its potential or future customers, and creating upgraded products and services. On the other hand, the relevant rules of conduct should be adopted inside the company in order to create good working conditions for the employees and treat them equally (Wayne, 2010).

In addition, companies in the context of their business strategy invoke in their mission and vision not only issues of profitability but also their will for sustainable development, creating a balance between their economic, social and environmental purposes. Therefore, business managers, even though there is no regulation that imposes such actions, can be aware of social and environmental issues so as to create additional value for everyone (Stefanescu et al., 2012). A sustainable business must take into account the interests of future generations, biodiversity, animal and human rights protection, life cycle impacts, and principles such as accountability, transparency, education and learning (vanKleef & Roome, 2007 ).

## 1.4. Corporate social responsibility

The economic growth prevailing in recent years and the prosperity of most businesses contributed to the indifference not only to the natural environment but also to the human factor. At the same time, there was a prevailing perception that businesses are impersonal and cannot be socially responsible. However, this view was quickly rejected as most businesses serve social and environmental roles and thus a strategy of business ethics was developed in their internal and external environment (Stefanescu et al., 2012).

It is clear that in business there are various groups whose demands conflict with each other, but managers should serve the interests of all parties involved. So, the satisfaction of all interested parties is impossible. Typical example, banks where depositors seek high returns, but this results in high costs for the bank. On the other hand, borrowers wish to receive loans at the lowest cost, but this negatively affects the bank's performance. In addition, bank owners are interested in earning more by paying less which holds back the bank's ability to provide its staff with reasonable benefits.

In addition, regulators are involved in reducing the risks a bank may take in obtaining and using funds. This limits the bank's ability to satisfy other stakeholders (Rebai et al., 2012). The constantly changing environment in which businesses operate requires their activation by including 'Corporate Social Responsibility' (CSR) actions in their daily activities. Due to the fact that the concept of CSR is complex, there is no universally accepted definition.

So, organizations have formulated their own definitions according to the priorities they set for the various issues that concern them (Stefanescu et al., 2012). In the Green Paper the European Commission defines CSR as a concept whereby companies integrate social and environmental interest in their business operations and interact with stakeholders on a voluntary basis (European Commission, 2012).

According to the international non-profit organization BSR, CSR is defined as "the ability of a business to ensure continued sustainability and satisfactory profitability by operating in ways that honor ethical values and respect employees, local communities and the natural environment. The set of CSR policies, practices and programs is integrated into business processes, supply chains and decision-making processes throughout the enterprise and includes accountability for current and past actions, as well as for future actions."

The Hellenic Network for Corporate Social Responsibility has given the following definition: "Corporate Responsibility is the voluntary commitment of businesses to include in their business practices social and environmental actions, which are above and beyond what is imposed by current legislation and are related with all those affected by

their respective activities, with the aim of achieving balanced profitability and sustainable development".

In addition, the definition of CSR is given by Carroll's model (1991) which refers to four types of social obligations which are, the financial responsibility of profit, the legal responsibility of the company to comply with the laws, its moral obligation to act in the social classes, although it is not legislated and finally, its charitable responsibility to promote actions that contribute to the promotion of social welfare.

Taking into account the characteristics of modern societies, the goal of CSR extends to the creation of a dynamic competitive and coherent knowledge-based economy. So, most companies responded to the concerns of recent times and integrated CSR actions into their business activities by allocating more resources to them.

CSR actions were considered by many as a proactive business strategy, an effective marketing tool that will help create and maintain competitive advantage. Therefore, social responsibility is not a waste of business money, but a long-term investment.

For this reason, it is considered appropriate to separate the short-term strategy from the long-term CSR strategy as individual actions such as donations and donations do not constitute effective business strategies. Thus, priorities should be set by the company in terms of the issues that will be targeted, the interested members should be identified and the corresponding working groups with a corporate social responsibility officer should be set up.

Thus, the company's commitments to social and environmental issues should be carefully planned, monitored, regularly assessed and finally made public. This communication can be carried out through social and thematic reports, codes of ethics, information through the internet, consultation with various stakeholders, internal communication, awards, events, etc. (Uslu et al., 2015).

However, in some companies, management has resisted them, arguing that additional CSR investments are inconsistent with efforts to maximize profits. Also, the fact that there is no organized institutional framework from the state apparatus for the implementation of CSR actions leads many to argue that all this is a creation of modern marketing (Linetal., 2009).

## 1.5. Corporate social responsibility and the Environment

Another field of application of CSR is the environment, as a large majority of companies show a strong interest in this, due to the fact that consumers are more ecologically aware. In the context of the 'environment' sector, businesses voluntarily adopt practices and actions to protect it. Even consumers themselves are more aware and prefer to buy products that are environmentally friendly even if they are more expensive and prefer to do business with businesses that adopt such measures (Lyon&Maxwell, 2008).

Today, businesses are taking a stand in the climate change debate not only in matters concerning their own operations but also in public policy. Many managers perceive climate change as the new business reality. According to Citigroup (2007), no business will be immune to this issue in the coming years. As a whole, businesses are interested in the environment, but they are mainly interested in themselves as their environmental actions improve their image and also contribute to reducing their operating costs. The power of non-governmental organizations has increased and for this reason companies in order to avoid consumer boycotts of their products are taking proactive measures to protect the environment.

The use of alternative forms of energy, the limitation of waste and their pollutants, the creation of innovative products, the adoption of friendly technologies, the cultivation of ecological consciousness in their employees, etc. are some of the practices that businesses use. The ecological consciousness of the company's employees will be achieved through various human resources information programs on issues such as e.g., is recycling.

In other words, companies should encourage employees to recycle the consumables they use, electronic mail should be promoted inside and outside the organization, as well as the electronic ordering of material should be promoted in order to save as much paper as possible. Also, it is very important to take initiatives for additional actions, such as reforestation, the cleaning of areas by the employees of the companies themselves with the participation of active citizens, informing the public and especially students about the protection of the environment with the aim the formation of a common environmental consciousness.

In addition, the environmental responsibility of businesses does not refer only to the production process but to the entire life cycle of their products, from the introduction, development, maturation and decline of their products which can be combined with their recycling. Regarding the supply chain, businesses should deal with suppliers and

transporters who are environmentally responsible and have products that meet international standards.

More and more companies, in order to reorganize their production process and face the pressures they received from their external environment, developed Environmental Management Systems (EMS). The most widespread standards are ISO 14001 or SA8000:2001 as well as the European EMAS Regulation. The benefits that can arise from the implementation of a BMS and certification with one of the previous standards are operational, financial and external.

However, the costs, difficulties and problems that arise from the implementation of an SPD should not be ignored. Therefore, the company should carry out a cost-benefit analysis in order to decide on the adoption of an EMS.

Corporate social responsibility and banks the functionality and performance of traditional banking is being questioned, due to the credit crisis, which requires a comprehensive integration of ethical values and principles in banking practices. The concept of CSR is increasingly used in the banking industry, perceived as a tool for banks to develop a positive image and attract new customers.

More specifically, in banking marketing, CSR includes issues related to quality of life, ethical concerns regarding minority groups, and the environment. Thus, corporate social responsibility is increasingly recognized by banks that support such programs, undertaking educational, cultural, sports and environmental initiatives and applying sponsorships to vulnerable groups and charitable non-profit organizations.

Future business executives are expected to pay particular attention to environmental factors when making managerial decisions (Portney, 2008). In support of all this, many banks have already implemented environmental strategies and green banking tools, investing significantly in their environmental image in order to cope with modern challenges. (Evangelinos, et. al, 2009).

It is particularly emphasized that green corporate social responsibility (GCSR) in the banking sector uses the example of a socially responsible bank that offers savings accounts to the public and promises that its savings will be used to finance sound environmental projects (Scholtens, 2009). In particular, one area of corporate social responsibility that banks give particular importance to is the area of the environment where they follow a specific environmental policy.

This policy includes energy conservation, such as reducing electricity consumption, waste management (eg paper recycling) and compliance with environmental principles by their suppliers. In addition, by financing private initiative energy applications, banks appear to be more environmentally aware than other businesses.



Along with the need for CSR actions, "environmental marketing" or "green marketing" emerges as a key issue that could possibly contribute to solving the present crisis. At the same time "green marketing" can be seen as a tool for sustainable development and the satisfaction of various stakeholders. From the banks' point of view, the concept of green marketing does not significantly differ from the concept of green marketing of the other branches.

Thus, green marketing in the banking industry refers to the development of new, "green" financial products, such as loans that finance clean technology, and environmental strategies such as waste management programs that improve banks' environmental performance and reputation. In conclusion, the development of CSR on the part of banks is an integral part of their healthy development as they not only provide satisfactory returns to their shareholders but also undertake social obligations beyond those defined by law.

## 2. Regulatory Framework for Financial Institutions – Basel Committee

### 2.1. The regulatory framework in Financial Institutions

The mediating role of Banks between depositors and borrowers creates the need to supervise banks (To Vima, 2010). Banks lend (long-term), a multiple of their capital (derived from customer deposits) and must pay it back immediately (short-term) when demanded by depositors.

Thus, banks convert (Syriopoulos, 2008):

- the duration (from short-term deposits to long-term loans),
- the quantity (from small amounts of deposits to large amounts of loans),
- the risk (higher risk loans than the risk that depositors want to take) and
- the degree of liquidity (placements in less liquid assets than deposits) of available loan funds.

The trust of depositors in Banks affects the stability of the credit system and for this reason the supervisory authorities seek to ensure it. Deposits in Banks are subject to many risks which are not adequately assessed by depositors, due to a lack of information. In addition, banks, in order to be more profitable, take on higher risks than they are allocated and therefore, part of the risks are transferred to depositors.

To prevent the risk of mass withdrawal of deposits, deposit guarantee schemes operate per depositor up to a certain amount, setting the risk within acceptable limits and thus ensuring the public interest. The Bank ensures the establishment of reliable, effective and comprehensive policies and procedures for the evaluation and maintenance on a permanent basis of the amount, composition and distribution of own funds, which are deemed appropriate by the Bank's Management from time to time to cover the nature and the level of risk management undertaken or likely to be undertaken by the Bank. These policies and procedures are regularly reviewed and evaluated by the Group Risk Management Department to ensure their completeness and adequacy.

## 2.2. The Basel Committee

In 1974 it was founded the Basel Committee with the aim of formulating supervisory standards and guidelines for the operation of the banking system. In 1988 the Commission introduced a capital measurement system (Basel Capital Accord.) and in 1998 the supervisory framework of the international banking system (Basel I) was issued which aimed to address credit risk through the establishment of minimum capital requirements.

In 2004, for better management by Banks of the risks undertaken (the concept of operational risk is also introduced) and for their connection with capital requirements, the Basel Committee replaced the Basel I framework with the Basel II. Finally, with the Basel III framework, the Basel committee implemented regulatory standards regarding the capital adequacy and liquidity of banks (Georgoutsos, Staikouras, 2008).

### 2.2.1. Basel I

The Basel I agreement was aimed at harmonizing the capital adequacy rules of the Credit System internationally, as well as Credit risk. It concerns both the way in which the Banks' capital requirements are calculated from their assets in relation to their exposure to Credit risk and the determination of their supervisory capital.

Purpose of Basel I for Credit Institutions Internationally. was to secure adequate capital and create a more competitive industry. With Basel I, banks could reduce working capital through securitization of assets (e.g., mortgages) without reducing financial risk, thereby reducing the risk of Bank failure and the potential cost of their failure to depositors.

## 2.2.2. Basel II

With Basel II, banks changed the way they calculate their regulatory capital based on the risks they take, ensuring their solvency. Basel II is a comprehensive risk management methodology. It focuses on the supervisory examination process and market transparency, provides adequate coverage of financial and non-financial risks, and aims at the convergence of banks' supervisory capital and financial capital through the assessment of risk carried out by banks.

The Basel II regulatory framework requires compliance with the requirements of three pillars, the first of which concerns matters of calculating capital requirements, the second matters of supervision and control of risk management systems and, by extension, capital adequacy, and the third matters of market discipline through the publication of various procedures (Georgoutsos, Staikouras, 2008).

More specifically:

Pillar 1: The minimum supervisory capital against credit risk and against operational risk (with the addition of claims) is calculated. The minimum capital is defined as 8% of the equity in relation to the weighted assets (Vassiliou, Portfolio Management, 2008).

Pillar 2: Supervisory practices implementing Basel II

Pillar 3: Reporting requirements (through disclosure of financial and other data) to the supervisory authority, strengthening bank discipline. Basel II compared to Basel I upgraded credit risk management and introduced operational risk (as a concept) since it allows banks to choose between different approaches by type of risk (credit, operational and market), depending on the particular needs and their priorities.

For example, in the granting of a loan there should be a gradation of risk and the lower the risk, the lower will be the supervisory funds committed for the specific loan and by extension the customer will benefit due to the lower interest rate. For a more effective use of the framework, it is necessary to improve the internal processes for Risk Management of each bank, for the calculation of both the supervisory capital and the internal financial capital (i.e., the minimum capital required to achieve the desired financial result).

### 2.2.3 Basel III

The purpose of the Basel III framework is to provide additional protection to banks against their exposure to credit risk from items in their portfolio. Banks must assess the credit risk of their exposures when calculating capital requirements to cover credit risk regardless of whether or not there is a credit assessment and check the appropriateness of the weighting factors applied to those exposures. (Chernobai, Rachev, Fabozzi, 2007). Also, the supervisory authorities must check the eligibility criteria of the Credit Rating Agency, in order to select it.

The innovative elements of the Basel III accord are (Gortsos, 2010):

- The leverage factor (its amount is 3%) which is established in order to avoid excessive leverage of banks (Vasieliou, Financial Management, 2008). The rate is not risk-based (i.e., assets are not risk-weighted), and will be applied in addition to capital adequacy requirements as a safety measure.
- Two liquidity coefficients are established (Basileiou, Financial Management, 2008):
  - The liquidity coverage ratio (short-term), to ensure sufficient liquid assets to cover overdue liabilities.
  - The coefficient of net fixed financing (long-term), to deal with the non-synchronization of the liquidation of the assets and liabilities of the banks' balance sheets and to create incentives for the banks to use fixed sources of financing of their assets (with a duration longer than a year).

### 2.3. Forms of operational Risk

The following forms/categories of operational risk are recognized (Piraeus Bank Group, Policy, 2017):

- Legal risk and compliance risk: They are considered as a sub-category of operational risk and are defined as risks of legal and regulatory sanctions, financial losses or the effects on the reputation of the Bank or the Group arising due to circumvention or non-compliance with the legislative and regulatory framework, the contractual obligations and the code of conduct related to their activities. It also includes exposure to new regulations, newly enacted laws as well as changes in interpretations of existing laws.
- Loss or Conduct Risk: Resulting from losses arising from an inappropriate offer for the provision of financial services.

- Systems risk (information and communication technology (ICT) (Myrtidis, 2008): The current or potential risk of loss due to the unsuitability or damage of the hardware and software of the technical infrastructure that may jeopardize the availability, integrity, accessibility and the security of the Bank's infrastructure and data.
- Money Laundering / Terrorism Risk: The possibility of financial losses and negative effects on reputation arising from the use of Bank or Group services and money laundering or terrorist financing.
- Reputational risk: The current or potential risk to the profits, equity or liquidity of the Bank and by extension the Group due to damage to their reputation, the loss of trust or the disappointment of investors, depositors or participants in the interbank Buy.
- Environmental & Social Risk: The risk arising from the business activities of the Group's clients and its customers or the business activities of investors with a negative impact on the environment or society. These two risks are also linked to credit risks, market risks, legal risks and reputational risks.
- Outsourcing risk: The risk from outsourcing, mainly due to the dependence on third parties or their inability to fulfill their contractual obligations.
- Risk from internal fraud: The risk of losses due to fraud, misappropriation of assets or circumvention of the Bank's regulations, legislation or policy.
- External Fraud Risk: The risk of damages resulting from someone's actions intended to defraud or circumvent the law by a third party.
- Risk from employment practices and workplace safety: The risk of harm arising from acts that do not comply with employment, health or safety laws or agreements.
- Risk of damage to physical assets: The risk of damages resulting from loss or damage to physical assets from natural disasters or other events.

## 2.4. Benefits of green banking

Traditional banks about to go green require specialized talent, skills and experience because of the type of customers they have to serve. This results in green banks having higher operating costs, at least at the beginning of their operation. Also, differentiation problems arise as green banks limit their business transactions to those business activities that meet the requirements of green banking.

So, with a limited number of customers, they will have a smaller base to support. Even the reputation of banks is greatly affected if they have participated in projects that have been considered socially and environmentally harmful. Finally, many banks involved in green entrepreneurship are in their early start-up stage, which delays them from generating revenue as it usually takes three to four years for revenue to flow in (Mioara et al., 2014).

However, there are significant benefits to sustainable banking. More specifically, the benefits arising from sustainable banking are non-financial and financial benefits. The non-financial benefits can be summarized as follows: protection of reputation, providing banks with a competitive advantage over customers who care about social and environmental issues, enhancing their strategic position as a market leader, enriching the local community and customer base and contribution to retaining and attracting staff.

Additionally, economic benefits include the development of environmental consulting services, the creation of environmental risk collateral and environmental deposit accounts, investing capital in disadvantaged communities and underserved markets, financing social enterprises as well as small businesses, developing integrated services community development, including specialized non-profit services (Lymperopoulos et al., 2012).

The concept of green banking will be beneficial for consumers, banks and the economy. For consumers this means more loans and more deposits will be available through online banking. It also means better deposit rates for certificates of deposit, money market accounts and savings accounts. In addition, green banks will have lower fees and achieve reductions in interest rates for financing energy efficient projects (Sharma et al., 2013)

## 2.5. Retail Banking

The green retail banking products that have been developed to date are aimed at individuals, companies and small and medium-sized businesses. These include loans, credit and debit cards, traveler's checks, money orders, personal account management and insurance. More specifically there are (NATF, 2007).

- Home loans

In general, green mortgages offer lower interest rates than conventional ones for customers who want to acquire or invest in energy-efficient homes, devices with better energy consumption, renovations of buildings with the aim of better environmental behavior and finally the use of RES in homes. In some countries, incentives are created by government actions that promote the implementation of the European Union Directive on the reduction of energy consumption in the building sector (2002/91) and therefore these loans respond to these actions.

There are also countries where favorable terms are given for both new and old houses. In this case, a discount is given per year on the interest rate and there is no service cost for the installment each month. Recently, there are also cases where this loan is linked to offset projects, and each customer who participates in this program receives a pollution offset certificate (Green Carbon Offset Certificate).

In this way, the participant recognizes and is recognized for the environmental benefits with the choice he made for the green loan. To achieve this, the terms of the loan should not be restrictive in order to be widely used (Evangelinos et al., 2009).

- Commercial Housing Loans

These loans are intended for customers looking for the energy efficiency of commercial buildings. More specifically, it concerns traditional buildings with lower energy consumption as well as the reduction of waste and air pollution they cause. They thus contribute to reducing operating costs, improving their energy efficiency and extending their lifespan.

In some countries the repayment of the loan is made through the energy savings achieved. There are also cases where the acquisition of experience is a key point in the application of the product, while financial institutions use it to enhance their reputation. The bigger projects they fund, the bigger and better reputation they get (Doane, 2004).

- Consumer cash collateral

It concerns consumer loans with a lower interest rate for the installation of RES technologies. For these loans, banks cooperate with companies that have the equipment and also with environmental non-governmental organizations. The disbursement of these loans is made once, while the repayment depends on the respective legislations.

Loan for the purchase of a car or truck or fleet of cars Loans with lower interest rates for the purchase of cars or trucks or fleet that emit less greenhouse gases. They are mainly offered in the Australian and European markets (Aggarwal et al., 2014). In some countries there is a program for grading gases emitted by all types of cars and the interest rate moves accordingly. This has given up to 45% rise in car loans.

In Europe, there are financial institutions that offer car loans that link them with educational services and emission compensation programs. For example, with each such loan, instructions are also given for better driving, resulting in lower consumption (Aggarwaletal., 2014).

- Credit and Debit Cards

Many banks around the world issue cards linked to environmental activities. In European financial institutions, the product that offers compensation for the ecological footprint created by the card user with his activities is becoming more and more popular. This program can be implemented at little cost to the individual, with very satisfactory results. There are cases where a discount and a low interest rate are provided for green purchases (Hall et al., 2010).

- Personal accounts

In this case, some accounts are linked to annual green donations. More specifically, in Australia there are accounts that have been opened to support farmers who implement sustainable farming practices. In this way the bank gives grants based on the average balances in the specific customer accounts. In other cases, deposit accounts are linked to loans to support local companies that offer energy-saving systems. The aim of these accounts is for companies to reduce their waste, as well as the environmental pollution they cause, as well as to contribute to the saving of natural resources (Lalon, 2015).

- Green sales and moving products

In this category, the various financial institutions commit to donate a certain amount for every customer who comes to the bank and gets a loan, or opens an account, or gets foreign exchange or even credit cards. In addition, there are banks that encourage



the offsetting of carbon dioxide emissions associated with air travel. Therefore, in collaboration with compensation organizations, they created websites that support the specific product, where the capital collected is used for investments in energy conservation, forest restoration, and RES projects in developing areas (Levinsohn, 2013).

- Other products and services

Other products, widespread in the European market, mainly concern the leasing of environmentally friendly technology, or RES technology at preferential rates. In addition, there are several banks that are considering providing small loans to individuals and SMEs, who have traditionally been denied loan applications, with the aim of financing small environmental projects such as small solar installations. In many cases, such loans are highly promoted in developing countries (Mioara et al., 2014).

- Investment Banking and Corporate Banking

Many banks in the world provide products and services to large enterprises, institutions, governments and other public entities with complex financial requirements. Thus, in the matter of green banking products, a wide range of options appears depending on the address at hand (Uslu et al., 2015).

- Project Finance

This department mainly deals with loans for the financing of large infrastructure projects, such as telecommunications, raw materials. Today, some banks measure air pollution from investments mainly in the Energy sector. They encourage the use of alternative energy sources by quantifying the costs incurred due to pollutants.

In other cases, banks have developed service departments, or teams, which deal with large-scale RES projects. These projects either concern the bank's clients, or concern the bank's own projects. In addition, green products appear which are intended for investments in biofuels. The goal is to create a flexible product that meets the needs of each customer. In addition to biofuels, there are financial institutions that offer financing for wind energy investments (Sharma et al., 2013).

- Securitization

Large-scale infrastructures are financed by guaranteeing their securitization in cases where they are linked to the environment, i.e. when it comes to environmental infrastructures and projects. Through this collateral, banks buy new bonds at a guaranteed

price which are then sold to institutional investors. So based on this scheme, a first such product appeared, which enabled the development of a bond related to forests.

This bond is long-term, which corresponds to the long-term planning of investors. At the end of the project, a capital will have been collected and a special purpose company will be created that will use said capital to create infrastructure and purchase land and equipment. Cash flows from the project will be used to secure bond earnings. A similar product was created at another bank which involved disaster bonds. In this case the aim was to help insurers to finance the risk of disasters (Sharma et al., 2013).

- Venture Capital & Private Equity

In this product category, special emphasis is placed on environmental issues when financing companies through the capital market. In particular, banks can play a decisive and profitable role together with public listings for the supply of cleaner energy, the development of a pollutant market and the support of companies that market environmental products and services. Such loans are for working capital financing for environmentally conscious investments, before companies even go public. Thus, these green products offer the support of open public offering of companies of an environmental nature and the development of a pollutant market (Sharma et al., 2013).

- Other products and services

Environmental leasing and personal accounts that are linked to sponsorships and donations. Green insurances, which are linked to environmental features as well as premiums that adapt to clean technologies and pollution reduction. Many of the "green" financial products and services, mentioned above, either remain in the early stages of their development or implementation, or the data related to their success-failure has not yet been researched.

Because of this lack of data experience, any strict measurement should be taken with caution. Going forward, as more quantitative and qualitative evidence emerges for these products, there are a number of questions that must be addressed when measuring their performance. Therefore, the questions that should be addressed are the following (UNEP, 2007).

- ❖ They enable the achievement of high levels of financial performance,
- ❖ They have attracted a particularly large number of customers
- ❖ They have lasted over time and restarted from year to year,
- ❖ They have increased environmental awareness among all stakeholders, including customers and employees;

- ❖ They have received positive attention from the media and environmental NGOs.
  - ❖ They have encouraged the introduction of other environmental products and services.
  - ❖ They have improved awareness and corporate image among stakeholders.
- Electronic banking

The benefits arising from electronic banking for banks and their customers are visible and manifold. Thus, the electronic banking transactions carried out by customers through paying bills, making deposits and withdrawals, the electronic transfer of funds from their accounts via the Internet to a secure website of the bank, in turn contribute to the protection of the environment.

In fact, online banking is a service that is green in nature as it reduces the environmental footprint of banks by reducing the daily transactions of their customers. More specifically, the use of online banking, mobile banking, paying bills online, instead of the usual mail, opening accounts online with banks instead of the many bank branches help conserve natural resources, save paper, energy and costs for natural resources (Bahl, 2012).

## 2.6. Perspectives and Future Developments of Green Banking

Undoubtedly, the prospects for the development of green banking are more than promising. The problem of global sustainability is widely recognized around the world, so financial institutions have recognized sustainability as an important part of their plans and all their actions show that sustainable banking can be a powerful solution to the financial crisis.

Banks like most businesses have realized that they operate in a global and competitive market. Differentiating their products in terms of features is quite difficult and thus they have to turn to new business strategies.

In this light, banks realize that they will have to adapt to the new data by being more socially and environmentally sensitive. Therefore, environmental protection is a basic condition for sustainable development and a key pillar of Corporate Social Responsibility.

The cooperation of financial institutions with businessmen, governments and non-governmental organizations is deemed necessary in order to communicate the importance

of various green products to the wider society. In addition, from the cooperation of the above agencies, appropriate green products will be designed that will meet the real needs of all parties involved.

As mentioned above, green products should be attractive and flexible to customers, and if they last over time and continue to exist. Thus, in the future research should be conducted on new green banking products and services before they are introduced to the market.

Finally, another important element for the development of green banking is the familiarization of this concept by bank employees through their participation in educational programs related to the environment. In this way, bank staff will be sensitized to environmental issues affecting not only themselves but also their family members (Lymperopoulos et al., 2012).

In recent years in Greece, important steps have been taken in the direction of green banking, with the country's largest banks developing various green products, however there is certainly room for improvement as there are many who do not have sufficient information about them. All this must be considered in conjunction with the fact that our country has infinite possibilities to exploit renewable energy sources in order to face the economic crisis.

However, the economic problems of our country, the bureaucracy, the lack of stability in the political scene and in general the reluctance to undertake new investments are obstacles for the development in areas of sustainable development. All these problems are exemplified by the latest statistics from the Association of Photovoltaic Companies, which are disappointing.

More specifically, there was a drop in employment due to the suspension of licensing of new projects, which employment was essentially based on projects that had matured for licensing from a long time ago and were simply executed in the specific period, as it was done in an attempt to correct the older institutional failures.

So, Greece, more than ever, will have to regroup in matters related to sustainable development, adopting the good practices of other countries and integrating them into Greek culture. An important step in this direction is to create a strong and stable legislative and regulatory framework, which will provide significant investment and tax incentives (Lymperopoulos et al., 2012).

In conclusion, Greece should understand the importance of its natural wealth and try to use it to its advantage, with the sole aim of extricating itself from the economic crisis that has plagued it in recent years (Lymperopoulos et al., 2012).

## 3. Data and methodology

### 3.1. Introduction

One of the most significant issues that concern the financial community, is the identification of an efficient scheme for the prediction of the credit risk, which in simple words is the risk assumed by the financial institutions under the case that the borrower (business or private consumer) is unable to fulfill its financial obligations towards the organization. Many researches have examined this issue, but even today they are trying to identify patterns through which they would be able to predict such events under the highest possible chances. This topic has attained particular research interest in studies that examine various financial crises, as this of 1926 (when things were simpler), but also the 2007 crisis (where issues were much more intense because of the broad range of financial products and financial elements that existed).

Since 2000, the issue of carbon emissions reduction (and the replacement of conventional energy resources with green energy, which is based on renewable energy sources) has come to the forefront. Towards this direction, enterprises have been encouraged to undertake a transition from conventional energy sources to green. Taking into account the significant cost of such a development, it is easy to understand that financial institutions demonstrate a crucial role to this process. Enterprises that seek to adopt the use of green energy seek funding for such initiatives from the banking system. Thus, green loans since 2000 represent an increasing part of financial organizations portfolios. Therefore, the risk that arises from such loans has to be integrated to the credit risk management profile of banks.

The purpose of this thesis is to build and implement a model that is going to be based on the financial data of the banks, taking into account the risk that arises from the CO<sub>2</sub> emissions reduction funding, and through which it would be able to predict, dangers that green loans may generate to the banking system sustainability of each country. The model that is going to be constructed is going to be based to data that were retrieved from international organizations, taking into account aspects related to both the banking system as well as the overall financial situation of European economies.

## 3.2. Data collection process and the final sample

The sample included data covering the period 2000 – 2021. Six EU member countries, which are important economies, were investigated, while data on the examined variables were available in the period of interest in the World Bank database (<https://data.worldbank.org/>). The countries included on the sample were France, Germany, Italy, Spain, the Netherlands and Poland. They are the European economies with the higher GDP for the year 2021. They were selected under this criterion, as well some other aspects related to their industrial sector (a major source of CO<sub>2</sub> emissions) and their efforts to undergo a reduction process and adopt a transition towards green energy sources).

Germany has a social market economy with a skilled workforce, a low level of corruption and a high level of innovation (Schwab, 2018). It is the third largest exporter and third largest importer of goods in the world. Germany is the largest economy in Europe, the fourth largest economy in the world by nominal GDP and the fifth largest economy by GDP in the world. The service sector contributes about 69% of total GDP, industry contributes 31% and agriculture 1%.

The automotive industry in Germany is very developed. It is one of the most competitive and innovative in the world, but also the fourth largest in the world in terms of production volume (Randall, 2019). Germany exports vehicles, machinery, chemicals, electronic products, electrical equipment, pharmaceuticals, transportation equipment, base metals, food products, rubber, plastics, and many other items. Twenty-nine of the 500 companies in the Fortune Global 500 index, the index of the 500 listed companies with the highest profits, are based in Germany. Research and development is an integral part of the German economy. In 2018, the number of published scientific and engineering research papers in Germany was the fourth highest in the world (McCarthy, 2020). Significant effort has been placed on the reduction of CO<sub>2</sub> emissions through the identification of alternative sources and energy saving schemes.

France has a developed high-income mixed economy, characterized by significant state participation, economic diversity, a skilled workforce and high innovation. For nearly two centuries, the French economy has consistently ranked among the ten largest in the world. It is currently the ninth largest in the world by purchasing power parity, the seventh largest by nominal GDP, and the second largest in the European Union by both measures. France is considered an economic powerhouse, a member of the G7, the leading industrialized countries, the Organization for Economic Co-operation and Development (OECD) and G20.

French economy is highly diversified: services account for two-thirds of both the workforce and GDP (Richter, 2020) while the industrial sector accounts for one-fifth of GDP and a similar proportion of employment. France is the third largest manufacturing country in Europe, behind Germany and Italy, and ranks eighth in the world in terms of share of global manufacturing output, with 1.9%. France also pays significant attention to the reduction of CO<sub>2</sub> and the development of renewable energy sources.

Italy is the third largest economy in the E.U. Furthermore, it is the second largest manufacturing country, behind Germany. The Eni group of companies engaged in the export of oil, mineral oil and energy is the Italian company with the largest turnover. Other important industries of the country are active on the production of engines, airplanes (Leonardo), ships (Fincantieri) and cars. Famous Italian car industries are the FIAT group of companies, which includes Alfa Romeo, Iveco, Lancia, Maserati, Ferrari, Piaggio and Pirelli. Significant renewable energy projects (particularly based on wind and solar energy) are deployed in Italy.

Spain is the fourth largest economy in the E.U. The Spanish industry has experienced particular growth since joining the EU in 1986. It started with labor-intensive products but today it is increasingly developing into the construction of highly legible products based on modern industrial design, such as the products of Inditex (owner of the Zara chains, Massimo Dutti, Pull and Bear, Bershka etc.), SEAT cars (SEAT, owned by Volkswagen), and Roca sanitary products. Due to the increase in wages, more and more often the production is transferred abroad (Europe, China) while the management and product design remain in Spain. The climate of Spain is suitable for the deployment of renewable energy sources; thus significant relevant efforts are being developed.

Netherlands is the fifth largest economy in the E.U. The Netherlands maintain a well-organized economic system. The chemical industry and the manufacturing of electrical products form two major sectors. Furthermore, the Netherlands pay significant attention to the development of wind energy, as well as biofuels, while the country has put on practice a national strategy of further reducing CO<sub>2</sub> emissions through the development of additional green energy projects.

Poland is the sixth largest economy in the E.U. It is mainly an industrial country, based to the huge amounts of coal that the Silesia region in the south of the country contains, which are used as the main source of energy. In addition to coal, Poland's subsoil offers iron, copper, lead, zinc, lignite, sulphur, natural gas, oil and mineral salt. The most important branches of Polish industry are metallurgy, steelmaking, mechanical engineering, textiles, followed by the chemical, food, paper, electrical, rubber and cement



industries. In addition, in Poland there is also one of FIAT's vehicle factories in the Bielsko-Biala region. Poland mainly exports coal such as zinc, machinery, textiles and agricultural products. The energy sources used on the country's industry generate a significant number of CO<sub>2</sub> emissions. However, currently there are not many initiatives to replace them by green sources. Taking into account the overall directions of the E.U., this is going to form a major issue during the future, and due to the Polish industry size significant funds are going to be necessary in order to achieve a transition towards green energy sources. The banking system is going to have a crucial role towards the accomplishment of this objective, therefore the case of this country is going to be examined in this research.

The sample of the present study consists of country indices, which are related both to the banking system structure and the loans policy sustainability, and indices that concern the general financial situation of each country as well. This choice was made so that the final result can be applied to each country as a whole. Furthermore, comparisons between countries can take place. The sample consists of 6 countries, while the data concerns a period of time from 2000 to 2021. I used this specific period because that is when concerns about CO<sub>2</sub> emissions and their reduction through the adoption of renewable and green energy sources began to occur. An appropriate financial model that would consider environmental risk, is going to be able to respond very well during future times, where the issue of the energy sources transition is going to become the epicenter of attention.

From the data retrieved from the World Bank database the relevant variables were calculated in order to be applied to the proposed model. The presentation of these variables is going to take place on the next section.

### 3.3. Variables

In this section the variables which have been selected based on the data provided by the World Bank database which are used in a broad range of financial analyses are going to be described. Many of them have been used in a series of studies and they are characteristic data in relation to the process of credit risk management.

The dependent variable of the proposed model is the CIR (credit infection ratio), which measures asset quality and credit risk. It compares the ratio of non-performing loans (NPLs) to gross loans and represents the lending due diligence process. It is used in order to evaluate infection in the loan portfolio over two different time periods, different sectors or against an industry standard. A higher ratio denotes a high inflection of a bank with non-performing loans. It is represented as:

$$CIR_{it} = \frac{NPLs_{it}}{Gross\ Loans_{it}} \quad (1)$$



Rising Non-Performing Loans (NPLs) are going to have a double burden on bank performance. They will increase costs through requiring higher provisions or increasing capital protection. At the same time, there will be a drop in interest income which will generate downward pressure on the results. In the event that there are fewer non-performing green loan issues, banks will find it beneficial to concentrate on carbon-neutral borrowers (Umar et al., 2021).

The main independent variable is the provision of funding in order to achieve low carbon emissions (CNL – Carbon neutral lending). It is defined as the percentage of bank lending granted to low carbon emissions out of total credits. It is represented as:

$$CNL_{it} = \frac{LowCarbonLending_{it}}{TotalLoans_{it}} \quad (2)$$

There are several reasons for the reduction of credit risk if banks diversify their loan portfolios by increasing lending related to carbon neutrality. The borrower's ability to repay his obligation derives from his performance and financial flexibility. Trinks et al. (2020) noted that lower carbon emissions lead to resource efficiency that will support economic performance. Velte et al. (2020) reported that carbon performance leads to lower information asymmetry, increasing firm value. Gallego-Alvarez et al. (2015) highlighted the fact that achieving carbon neutrality improves corporate performance. Wang et al. (2020) suggested that the use of renewable energy sources supports economic growth. Fernandez-Cuesta et al. (2019) have shown that lower emissions help increase economic flexibility. Based on this data, it can be hypothesized that borrowers with lower carbon emissions should have a better ability to repay. Therefore, higher funding for achieving low carbon emissions (CNL) should be negatively related to default risk, reflecting a lower CIR. Sanchez-Serrano (2021) and Boumparis et al. (2019) noted a lag between loan extension and credit quality deterioration. Therefore, the lag of CNL is taken as the main independent variable.

To investigate the effect of exogenous factors on credit risk, some control variables are introduced. These include bank spreads (spread), government effectiveness (GEI), liquidity (liquidity), banking sector size (size), capital adequacy (CAR), growth rate of GDP and the foreign direct investments (FDI).

The bank spreads variable is going to be calculated from the following formula:

$$spread = \left( \frac{interest\ income}{interest\ earning\ assets} \right) - \left( \frac{interest\ expense}{interest-bearing\ liabilities} \right) \quad (3)$$

The government effectiveness indicator (GEI) measures the quality of public services, the quality of the civil service and its independence from political pressures, the quality of

policy formulation and implementation, and the credibility of the government's commitment to its stated policies. Countries are evaluated on various factors. Countries with more effective governments tend to achieve higher levels of economic growth by obtaining better credit ratings and attracting more investment, offering higher quality public services and encouraging higher levels of human capital accumulation, putting foreign aid resources to better use, accelerating technological innovation, and increasing the productivity of government spending.

Liquidity is calculated from the following formula:

$$liquidity = \frac{Loans}{Deposits} \quad (4)$$

Liquidity measures cash and other assets that the banks have in order to be able to correspond to their short-term business and financial obligations. A low level of liquidity denotes a bank that is not able to fulfill its obligations.

The size of the banking sector (size) is going to be calculated from the following relationship:

$$size = \ln (Total\ assets) \quad (5)$$

According to a relevant study (Adusei & Elliott, 2015), bank size has a negative impact on bank stability, in other words larger banks are less stable than smaller banks.

Capital Adequacy Ratio (CAR) is calculated from the following formula:

$$CAR = \frac{Supervisory\ capital}{Risk\ Weighted\ assets} \quad (6)$$

Capital Adequacy Ratio (CAR) is the ratio of a bank's capital in relation to its risk weighted assets and current liabilities. It is decided by central banks and bank regulators to prevent commercial banks from taking excess leverage and becoming insolvent in the process. According to the Basel III norms, banks have to maintain a CAR of at least 8%.

The GDP growth rate compares the yearly change in a country's economic output in order to measure how fast its economy is growing.

The FDI restrictiveness index measures statutory restrictions on foreign direct investments looking at four main types of restrictions: foreign equity restrictions;

discriminatory screening or approval mechanisms; restrictions on key foreign personnel and operational restrictions.

IRV (Interest rate volatility) is the standard deviation of interest rate. It represents the variability of interest rates on loans and savings over time. Volatile interest rates affect enterprises, since they increase the cost of funding and investment account earnings.

### 3.4. Methodology and model

The methodology that was selected to be applied was based on Umar et al.'s research (Umar et al., 2021). The sample of countries, retrieved by the World Bank database was not able to be separated into different categories, i.e. countries in order to conduct six different regressions (each one per country) due to the low number of values (21 values per country). Therefore, panel regression was chosen as the most appropriate method in order to identify differences between countries. Furthermore, information about one variable of Umar et al. (2021) was not able to be retrieved for the present sample. Therefore, bank efficiency was replaced by government efficiency. It has to be mentioned that since Umar et al. (2021) examined specific banks, while the present study is focused on country economies government efficiency forms a more suitable variable, taking into account the factors mentioned on its description in Section 3.3. The proposed methodology is going to be described below.

In the methodology that was applied an econometric model was built with the actual data available from the World Bank database. These data were used in order to calculate the variables needed in the construction of the proposed econometric model. In its construction the method of Panel Data Regression was applied.

The interpretive capacity of the constructed model was analyzed in relation to the statistical significance of the variables that were used and of the proposed model in general. The main objective was to reach the result that was expected and not to reject it and this is the purpose of this thesis.

The method that was applied was the panel data regression, in order to investigate the relationship between a dependent variable  $Y$  and the independent variables  $X_1, X_2, \dots, X_n$  across the six countries that constituted the sample of the research. Regression is one of the most important applications of statistics. It is a quantitative method widely used in empirical research in economics. With this it is able to determine the coefficients of the relationship. Of course, the values that are going to be found will have some deviation from the real values, that is, some error.

The process of econometric analysis that is going to be applied in this thesis, as well as the data processing that is going to be conducted after collecting the data until the calculation of the final results is going to form the basis in order to draw some reliable conclusions in relation to the prediction of the environmental risk and its impact to the credit risk portfolio of banks. This is the purpose of the present thesis, so that an identification of the impact of environmental risk to the bank's portfolio could take place.

The model that is going to be applied and which is going to be presented below has the following form:

$$X_{it} = b_0 + b_1X_{1,t-1} + b_2X_{2,t-1} + b_3X_{3,t-1} + \dots + b_iX_{i,t-1} + \varepsilon_i \quad (7)$$

The total variables that are going to be used will eventually be ten along with the constant term. The dependent and independent variables have been mentioned and analyzed above. Furthermore, data that were used in order to construct them, a general description of their implications and why they were used were also described on the previous section. The econometric model that was used for the purposes of the present study is shown below:

$$CIR_{it} = a_{it} + \beta_1CNL_{it} + \beta_2spread_{it} + \beta_3efficiency_{it} + \beta_4liquidity_{it} + \beta_5size_{it} + \beta_6CAR_{it} + \beta_7GDP_{it} + \beta_8FDI_{it} + \beta_9IRV_{it} + \varepsilon_{i,t} \quad (8)$$

### 3.5. Descriptive statistics

The descriptive statistics regarding the variables that were used in the proposed financial model and a brief analysis of how they change from year to year are presented below. The descriptive statistics that are going to be reported for each variable are:

- **Mean:** is the mean of a set of n observations.
- **Maximum:** is the maximum value in a set of n observations.
- **Minimum:** is the minimum value in a set of n observations
- **Standard deviation:** it is the average dispersion of the values around the mean, i.e., the percentages of concentration around the mean.
- **Skewness:** is a measurement of the asymmetry or distortion of symmetrical distribution.
- **Kurtosis:** is a measure of the "tailedness" of the probability distribution of a random variable with real-valued outcomes.

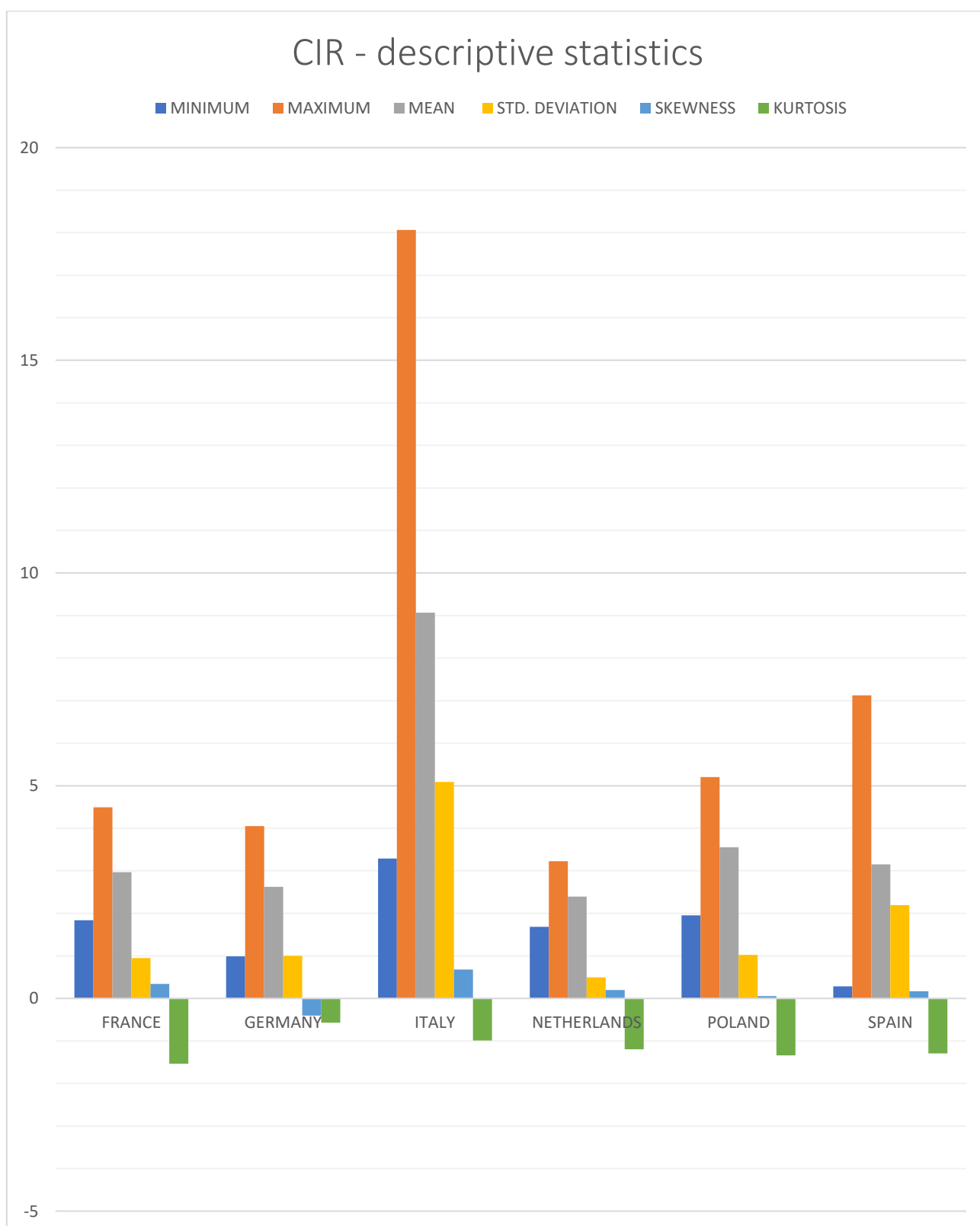
The descriptive statistics along with the corresponding graphs are going to be presented for all years and for each variable separately along with a brief analysis of what they show. They are going to be presented separately for each country of the sample.

The descriptive statistics and the graph for the dependent variable (CIR) are shown in Table 1 and Figure 1.

**Table 1: CIR descriptive statistics (percentage)**

COUNTRY	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION	SKEWNESS	KURTOSIS
<b>FRANCE</b>	1.83748	4.495434	2.966629	0.946609	0.343306 135	- 1.533487 258
<b>GERMANY</b>	0.99	4.05	2.622727	0.999887	- 0.404796 91	- 0.568461 525
<b>ITALY</b>	3.2876	18.06437	9.067496	5.088965	0.678442 44	- 0.986496 333
<b>NETHERLANDS</b>	1.68139 8	3.227169	2.395524	0.496083	0.195301 736	- 1.197309 594
<b>POLAND</b>	1.95316 8	5.202039 832	3.552594 849	1.026077 668	0.054385 967	- 1.337050 826
<b>SPAIN</b>	0.28193	18.06436 883	3.958878 026	3.291370 391	0.168889 598	- 1.294828 264

<b>GENERAL SUMMARY</b>	<b>0.28193</b>	<b>18.06437</b>	<b>3.958878</b>	<b>3.29137</b>	<b>2.695529 901</b>	<b>8.049303 023</b>
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**Figure 1: CIR descriptive statistics (percentage)**

From the above Table 1 and Figure 1 it can be observed that the most important part is the standard deviation, which provides the dispersion of the sample's values around the mean and the mean. From the calculations it is obvious that the standard deviation of the

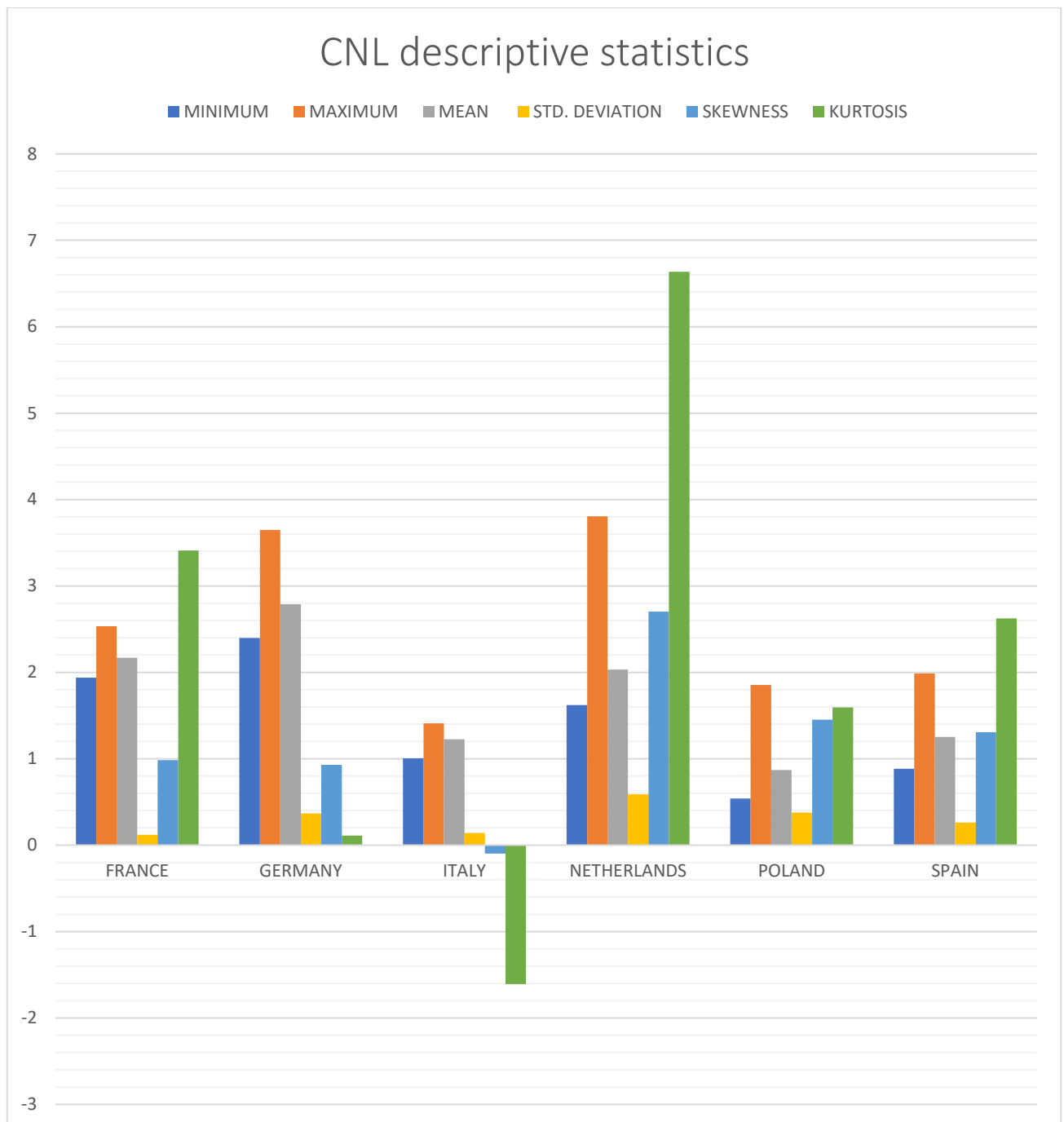
variable CIR is very small for the cases of France, Germany, Netherlands and Poland, which means that the spread of the sample values is very close to the mean. On the other hand, it reaches greater levels for Italy and Spain, however it is still lower than the mean. As for the mean, Italy demonstrates the highest average, implying that it maintains the highest number of non-performing loans, something that can be explained from the consequences of the 2007 financial crisis on the country's economy. On the other hand, other countries demonstrate lower values, which implies that they maintain their non-performing loans on lower levels. All the countries of the sample maintain acceptable skewness values (between -2 and 2), thus the data of each panel country can be considered normally distributed. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

The next variable that is going to be examined is CNL, with its corresponding descriptive statistics presented on Table 2 and Figure 2.

**Table 2: CNL descriptive statistics (percentage)**

COUNTRY	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION	SKEWNESS	KURTOSIS
FRANCE	1.93932	2.53423	2.168159	0.119248	0.984036001	3.410609525
GERMANY	2.39631	3.6478	2.786745	0.36821	0.930543109	0.109923493
ITALY	1.00546	1.40953	1.22521	0.142447	-0.096870444	-1.60768079
NETHERLANDS	1.62269	3.80638	2.031008	0.587664	2.701437985	6.634467274
POLAND	0.53884	1.85269	0.870325	0.375619	1.450948961	1.59353
SPAIN	0.88495	1.9859	1.252369	0.260685	1.306709914	2.623508327
<b>GENERAL SUMMARY</b>	<b>0.53884</b>	<b>3.80638</b>	<b>1.722303</b>	<b>0.745852</b>	<b>0.557013853</b>	<b>-0.081522412</b>





**Figure 2: CNL descriptive statistics (percentage)**

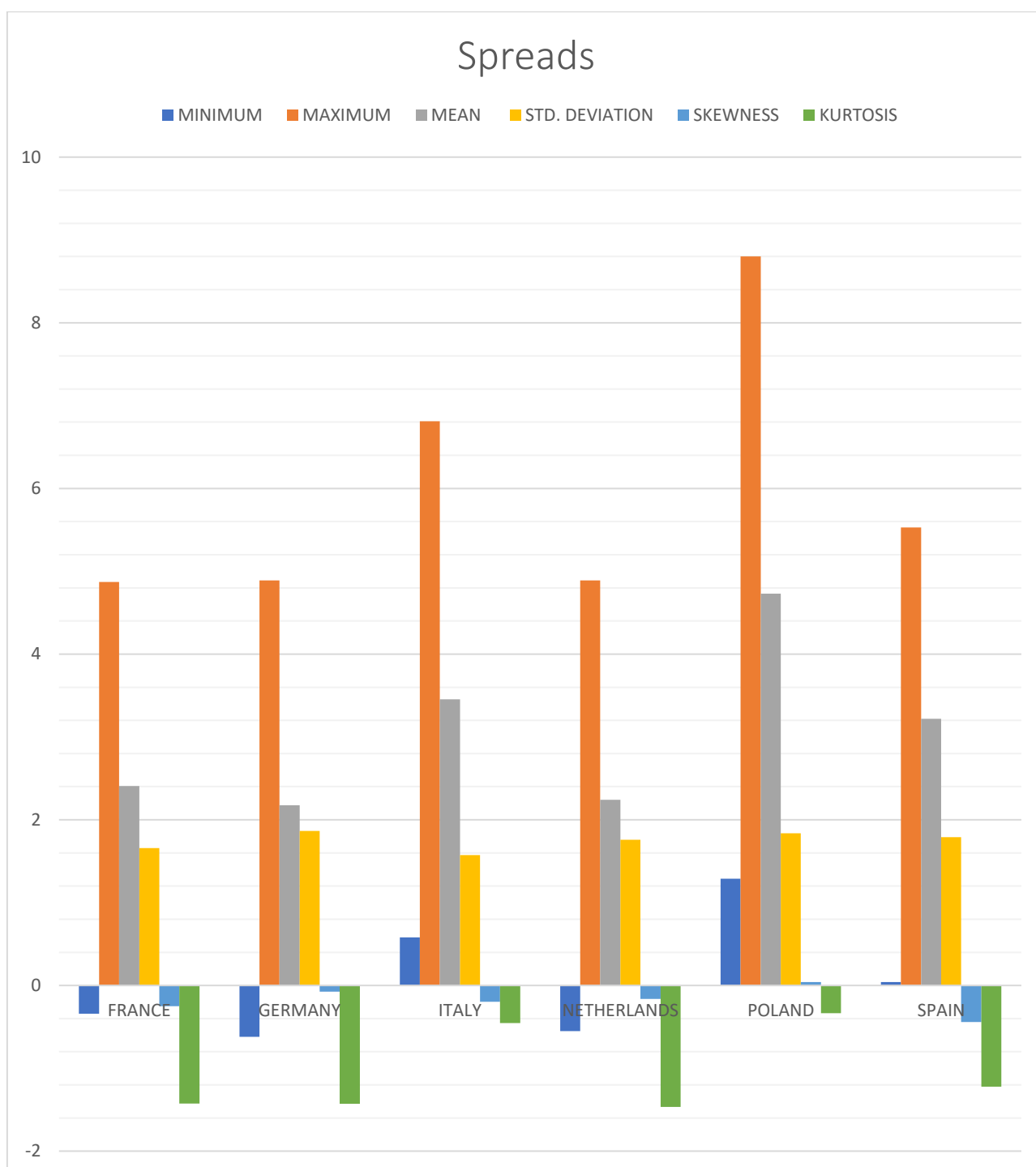
From Table 2 and Figure 2 regarding the variable CNL focus is given on the mean and standard deviation. It can be observed that the standard deviation is small in all the countries of the sample, therefore the price dispersion is close to the average. Germany, France and the Netherlands provide the highest percentage of loans in order to achieve carbon neutrality (measured as a percentage of the total loans their banking systems provide). This implies that their banking institutions follow a policy of supporting the transition towards green energy sources. Italy and Spain demonstrate lower CNL averages, which implies that their banking systems have not adopted a clear policy of

supporting carbon neutrality. This fact can be attributed to the implications of the 2007 financial crisis to the economies of these countries, with their banking systems facing difficulties due to restrictions in relevance to the provision of new loans. Finally, Poland demonstrates the lowest mean CNL. This finding confirms the country's lag in relation to the adoption of green energy sources. All the countries of the sample maintain acceptable skewness values (between -2 and 2) with the exception of the Netherlands; thus the data of each panel country can be considered normally distributed. The data of the Netherlands are positively skewed. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

The next variable that is going to be examined is spread, with its descriptive statistics being presented on Table 3 and Figure 3.

**Table 3: Bank spreads descriptive statistics**

COUNTRY	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION	SKEWNESS	KURTOSIS
FRANCE	-0.34	4.87	2.4077 27	1.658473	- 0.251156 824	- 1.425051 814
GERMANY	-0.62	4.89	2.1754 55	1.865317	- 0.073995 036	- 1.427980 469
ITALY	0.58	6.81	3.455	1.574486	- 0.195488 954	- 0.454475 97
NETHERLANDS	-0.55	4.89	2.2409 09	1.758243	- 0.162526 23	- 1.465634 252
POLAND	1.29	8.8	4.7286 36	1.837471	0.040525 406	- 0.335930 778
SPAIN	0.04	5.53	3.2186 36	1.791233	- 0.440416 216	- 1.221723 075
<b>GENERAL SUMMARY</b>	<b>-0.62</b>	<b>8.8</b>	<b>3.0377 27</b>	<b>1.939148</b>	<b>- 0.021902 625</b>	<b>- 0.551848 404</b>



**Figure 3: Bank spreads descriptive statistics**

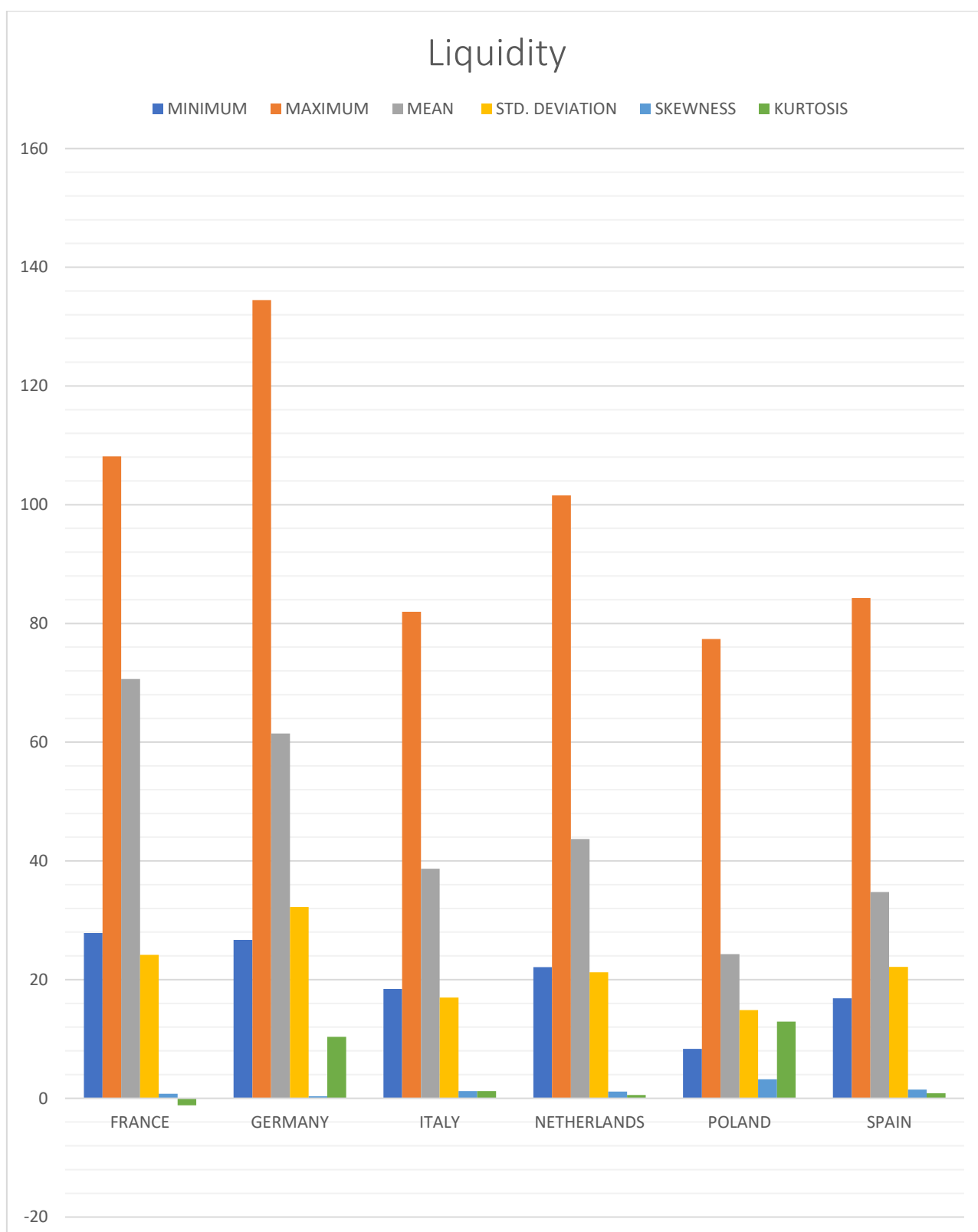
Examining Table 3 and Figure 3 for the variable of banking spreads it is obvious that Italy, Poland and Spain demonstrate standard deviations smaller than their means. On the other hand, France, Germany and the Netherlands demonstrate higher standard deviations, which implies a higher dispersion of their banking spreads across the examined time period. According to the findings, Poland maintains the healthiest banking system in terms of maintaining a high difference between earnings and expenses. Italy and Spain follow, something that can be attributed to the tight restrictions imposed to

their banks since being refunded from the European Central Bank after the 2007 crisis in relation to the provision of lending. France, Germany and the Netherlands also demonstrate high spread values. All the countries of the sample maintain acceptable skewness values (between -2 and 2), thus the data of each panel country can be considered normally distributed. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

The next variable that is going to be examined is liquidity, with its descriptive statistics being presented on Table 4 and Figure 4.

**Table 4: Liquidity descriptive statistics (percentage)**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	45.93	108.13	71.46273	22.92286	0.760819177	-1.194031022
<b>GERMANY</b>	26.69	134.47	61.11909	32.5766	0.351783284	10.36396841
<b>ITALY</b>	18.44	81.98	38.90682	16.87656	1.240324929	1.210102539
<b>NETHERLANDS</b>	22.1	101.58	43.85182	21.10688	1.124537859	0.550985088
<b>POLAND</b>	8.35	77.39	23.95636	14.70448	3.219677128	12.9058387
<b>SPAIN</b>	16.84	84.26	34.76318	21.61067	1.48254127	0.834127416
<b>GENERAL SUMMARY</b>	<b>8.35</b>	<b>134.47</b>	<b>45.67667</b>	<b>27.20584</b>	<b>0.986597639</b>	<b>0.146117533</b>



**Figure 4: Liquidity descriptive statistics (percentage)**

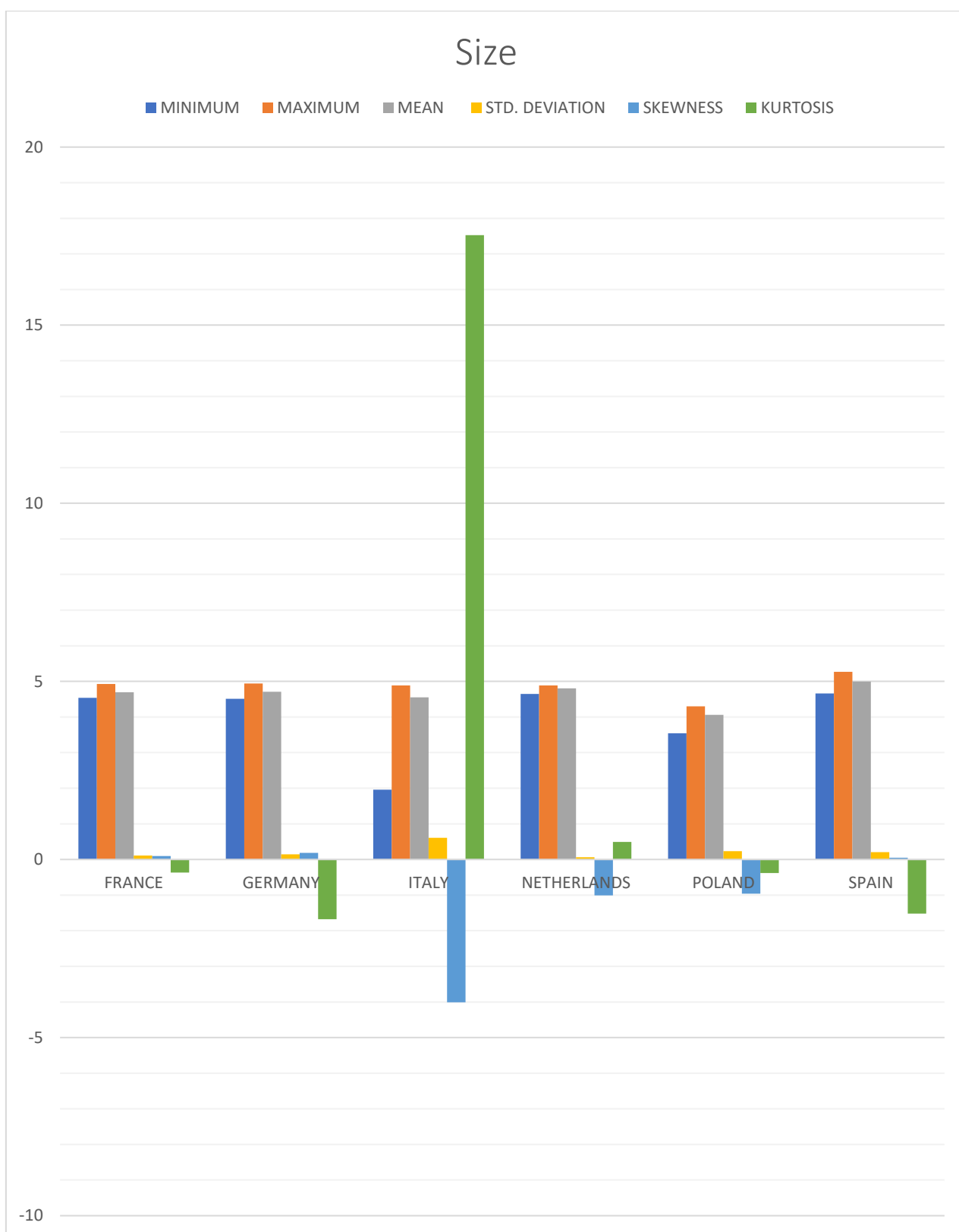
From Table 4 and Figure 4 it is obvious that the standard deviation demonstrates lower values than the mean, implying a concentration of the data around the latter. French and German banking systems demonstrate the higher percentage of loans in comparison to

deposits. They are followed by the Netherlands, Italy and Spain, with Poland demonstrating the lowest percentage of loans per deposits. All the countries of the sample maintain acceptable skewness values (between -2 and 2), with the exception of Poland, thus the data of each panel country can be considered normally distributed, except Poland which demonstrates positively skewed liquidity data. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed, with the exception of Germany and Poland (both countries demonstrate peaked distributions).

The next variable that is going to be examined is size, with its descriptive statistics being presented on Table 4 and Figure 4.

**Table 5: Size (ln)**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	4.539351	4.925223	4.692177	0.107873	0.096049778	-0.364404779
<b>GERMANY</b>	4.5091	4.93785	4.708348	0.146477	0.188807485	-1.674649896
<b>ITALY</b>	1.958826	4.883256	4.550832	0.60778	-4.01299746	17.52819966
<b>NETHERLANDS</b>	4.650144	4.884316	4.802259	0.062314	-1.01097163	0.495542853
<b>POLAND</b>	3.538928	4.30163	4.057948	0.233577	-0.963655852	-0.378913731
<b>SPAIN</b>	4.659469	5.269506	4.993525	0.206768	0.04907682	-1.522591446
<b>GENERAL SUMMARY</b>	<b>1.958826</b>	<b>5.269506</b>	<b>4.634181</b>	<b>0.406929</b>	<b>-2.676646374</b>	<b>13.79612896</b>



**Figure 5: Size (ln)**

From Table 5 and Figure 5 it is obvious that the standard deviation demonstrates lower values than the mean, implying a concentration of the data around the latter. France, Germany, Italy, the Netherlands and Spain demonstrate a higher size of their banking

THE INTEGRATION OF ENVIRONMENTAL RISKS INTO THE CREDIT RISK MANAGEMENT PROFILE

OF EUROPEAN BANKS

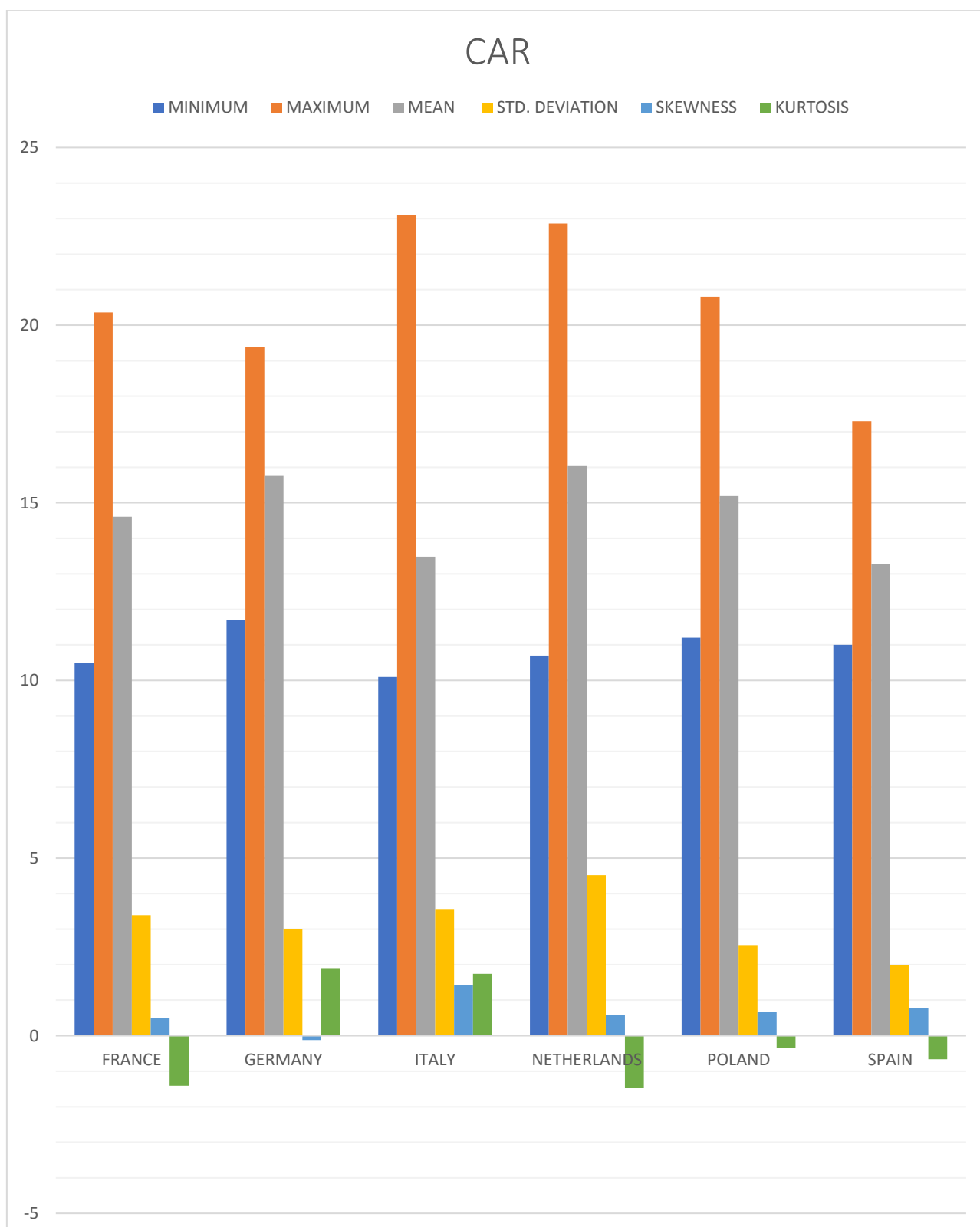
ZAVOS PANAGIOTIS ANDREAS

sector in comparison to Poland. All the countries of the sample maintain acceptable skewness values (between -2 and 2), with the exception of Italy, thus the data of each panel country can be considered normally distributed, except Italy which demonstrates negatively skewed size data. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed, with the exception of Italy (which demonstrates peaked distribution).

**Table 6: CAR**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	10.5	20.36	14.61	3.397208	0.504430 253	- 1.410796 905
<b>GERMANY</b>	11.7	19.38	15.758 18	3.000495	- 0.120978 527	1.904459 964
<b>ITALY</b>	10.1	23.1	13.483 64	3.566847	1.424772 281	1.743719 362
<b>NETHERLANDS</b>	10.7	22.86	16.033 64	4.523421	0.579311 27	- 1.476988 233
<b>POLAND</b>	11.2	20.8	15.189 09	2.550697	0.672664 731	- 0.342174 68
<b>SPAIN</b>	11	17.3	13.280 91	1.982026	0.780732 393	- 0.663391 014
<b>GENERAL SUMMARY</b>	<b>10.1</b>	<b>23.1</b>	<b>14.725 91</b>	<b>3.376361</b>	<b>0.783917 762</b>	<b>- 0.375247 418</b>





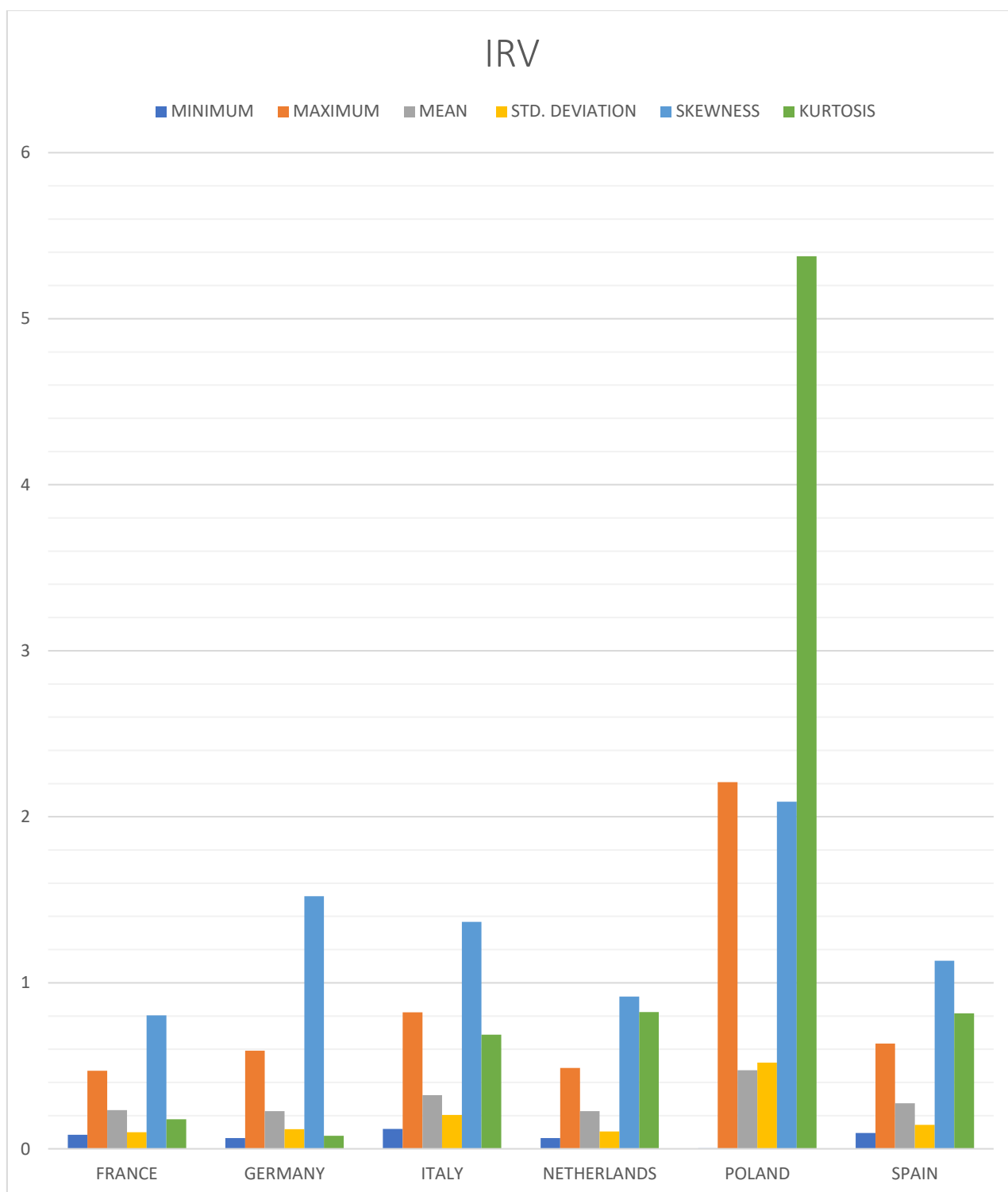
**Figure 6: CAR**

From Table 6 and Figure 6 it is obvious that the standard deviation demonstrates lower values than the mean, implying a concentration of the data around the latter. Italy and the

Netherlands maintain the highest CAR, followed by Poland and France. All countries of the sample satisfy the 8% threshold set by the Basel III norms. All the countries of the sample maintain acceptable skewness values (between -2 and 2), thus the data of each panel country can be considered normally distributed. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

**Table 7: IRV**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	0.084388	0.470669	0.232744	0.100148	0.803957264	0.177553385
<b>GERMANY</b>	0.065048	0.591734	0.226468	0.118971	1.521576541	0.078102115
<b>ITALY</b>	0.119937	0.822203	0.322865	0.204104	1.366664245	0.687824447
<b>NETHERLANDS</b>	0.06467	0.487602	0.227099	0.103968	0.916995864	0.824390425
<b>POLAND</b>	0.002887	2.208951	0.473581	0.519721	2.090409635	5.375795299
<b>SPAIN</b>	0.094623	0.633795	0.274459	0.14426	1.132684047	0.816109774
<b>GENERAL SUMMARY</b>	<b>0.002887</b>	<b>2.208951</b>	<b>0.292869</b>	<b>0.258244</b>	<b>4.083651974</b>	<b>24.9224421</b>



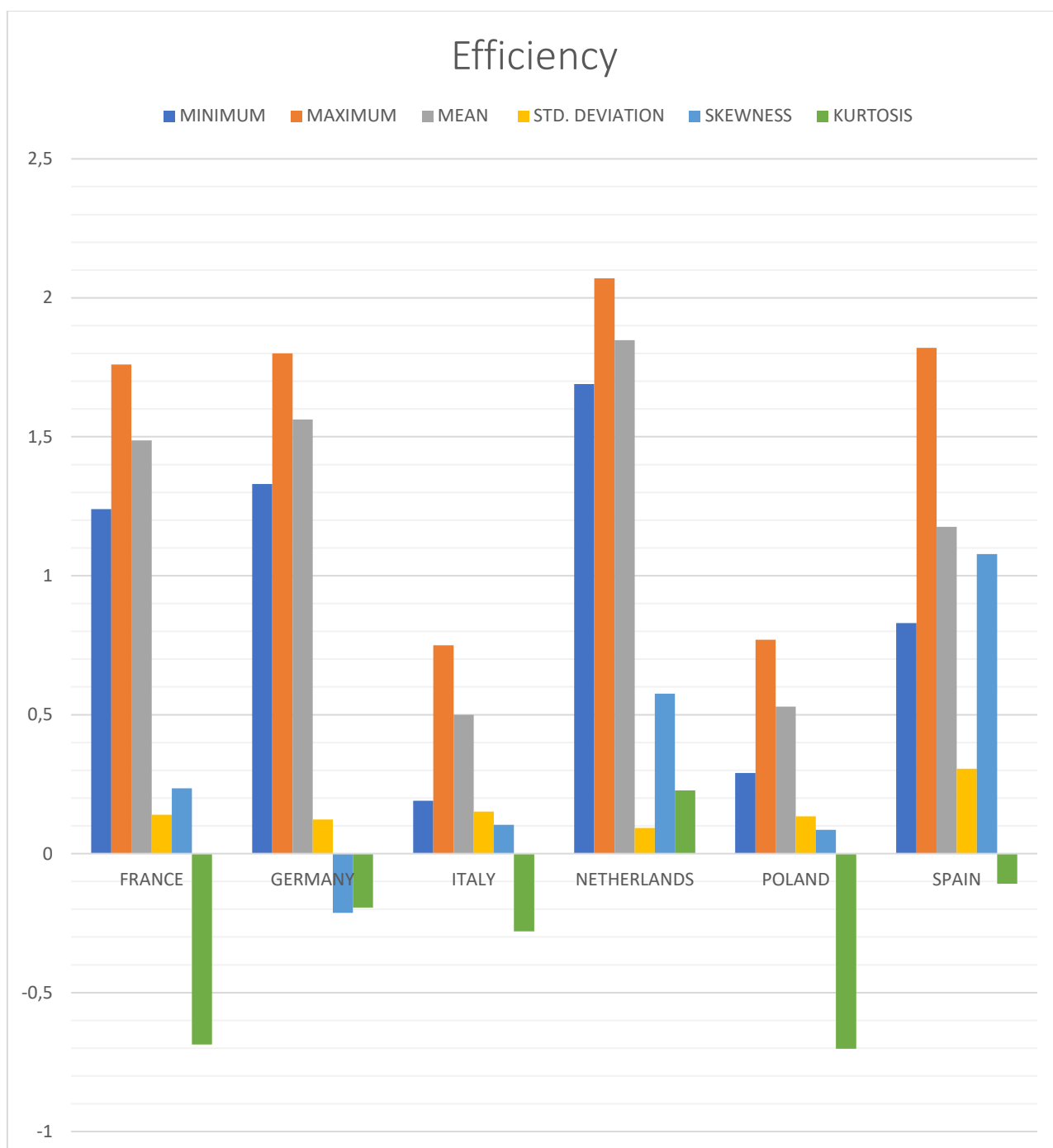
**Figure 7: IRV**

From Table 7 and Figure 7 it is obvious that the standard deviation demonstrates lower values than the mean for all the countries of the sample, except Poland, implying a concentration of the data around the latter. On the other hand, the Polish banks interest rates demonstrate a high volatility, since having lower mean than standard deviation.

Furthermore, the mean interest rate volatility (in contrast to the other countries) demonstrates a significantly higher value, implying that the country's banking system does not maintain stable interest rates, thus increasing the cost of funding for Polish enterprises. All the countries of the sample maintain acceptable skewness values (between -2 and 2), with the exception of Poland, thus the data of each panel country can be considered normally distributed, except Poland which demonstrates positively skewed IRV data. Kurtosis has values between the range of -7 and 7 for all the examined countries except Poland, thus normality is confirmed.

**Table 8: Efficiency (GEI)**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	1.24	1.76	1.487273	0.14021	0.235116	-0.6865
<b>GERMANY</b>	1.33	1.8	1.562727	0.123257	-0.21334	-0.19415
<b>ITALY</b>	0.19	0.75	0.499545	0.151138	0.103948	-0.27982
<b>NETHERLANDS</b>	1.69	2.07	1.847273	0.092437	0.575287	0.227522
<b>POLAND</b>	0.29	0.77	0.529545	0.134677	0.085353	-0.70188
<b>SPAIN</b>	0.83	1.82	1.175909	0.305391	1.078048	-0.10804
<b>GENERAL SUMMARY</b>	<b>0.19</b>	<b>2.07</b>	<b>1.183712</b>	<b>0.540841</b>	<b>-0.24667</b>	<b>-1.42859</b>



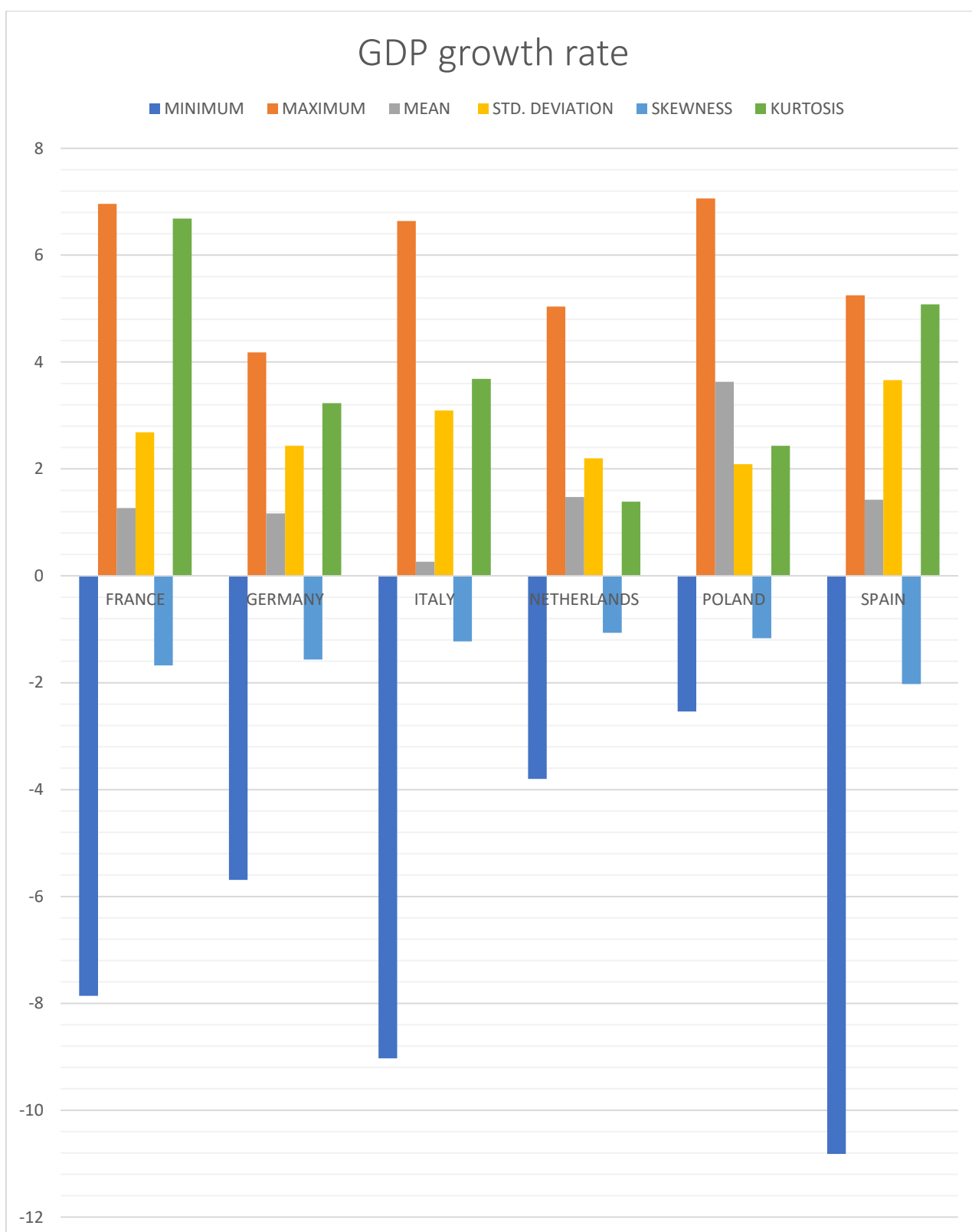
**Figure 8: Efficiency (GEI)**

From Table 8 and Figure 8 it is obvious that the standard deviation demonstrates significantly lower values than the mean for all the countries of the sample, implying a concentration of the data around the mean. The Netherlands maintains the highest government efficiency, followed by Germany and France. Spain stands on the middle, while Poland and Italy demonstrate the lowest prices. All the countries of the sample maintain acceptable skewness values (between -2 and 2), thus the data of each panel

country can be considered normally distributed. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

**Table 9: GDP growth rate**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	-7.86	6.96	1.268182	2.686314	-1.67753	6.685138
<b>GERMANY</b>	-5.69	4.18	1.169091	2.435284	-1.56863	3.232477
<b>ITALY</b>	-9.03	6.64	0.263182	3.094841	-1.22927	3.686599
<b>NETHERLANDS</b>	-3.8	5.04	1.474545	2.197886	-1.06548	1.388167
<b>POLAND</b>	-2.54	7.06	3.631364	2.087407	-1.16706	2.434874
<b>SPAIN</b>	-10.82	5.25	1.425	3.661861	-2.02674	5.078407
<b>GENERAL SUMMARY</b>	<b>-10.82</b>	<b>7.06</b>	<b>1.538561</b>	<b>2.883079</b>	<b>-1.45046</b>	<b>3.77972</b>



**Figure 9: GDP growth rate**

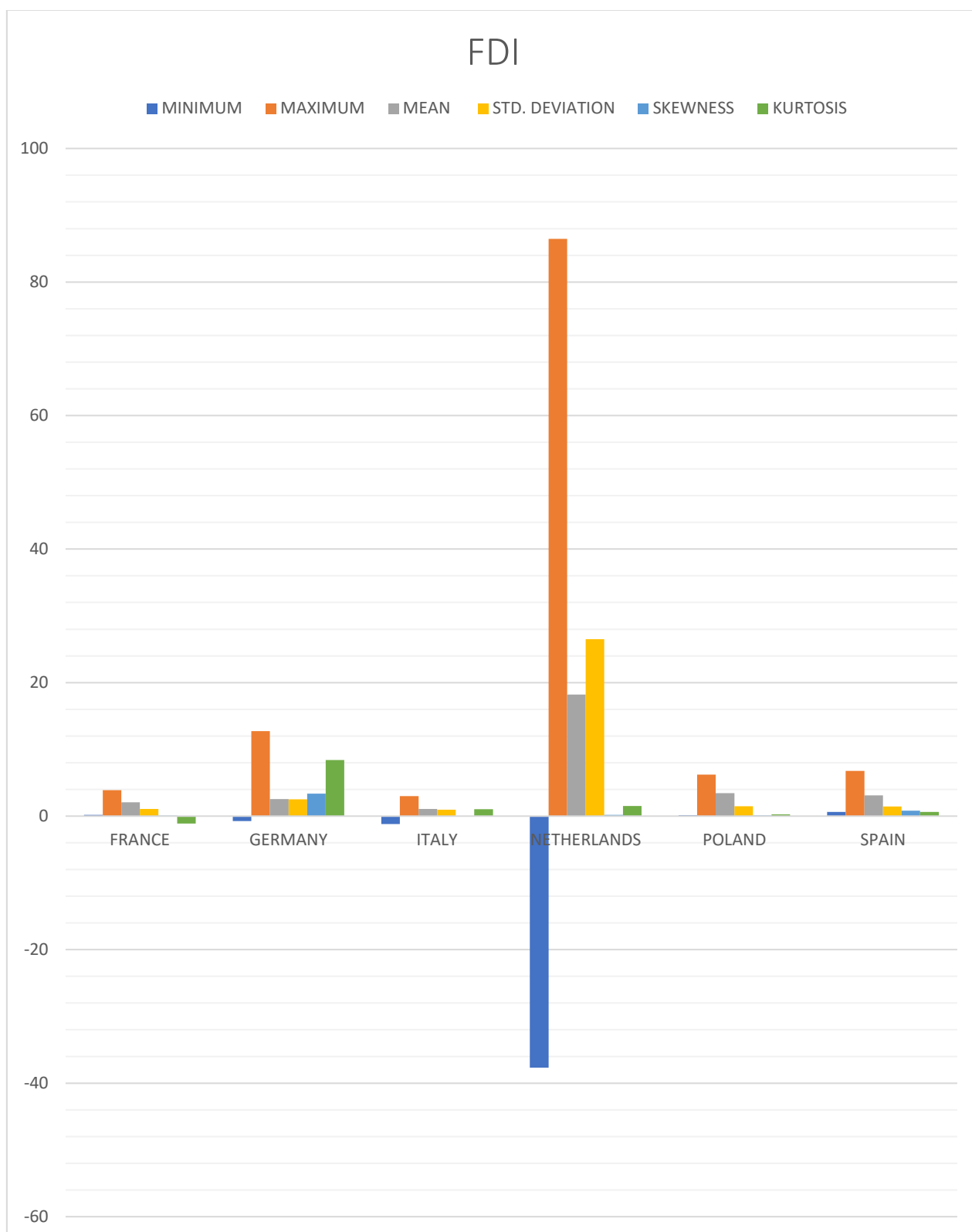
From Table 9 and Figure 9 it is obvious that the standard deviation demonstrates higher values than the mean for all the countries of the sample (with the exception of the Netherlands), implying a high dispersion of the data. Poland demonstrates the highest

growth rates, followed by France, Germany, the Netherlands and Spain. On the other hand, Italy seems to demonstrate a financial stagnation, with its average growth rate near zero. The negative minimum values are related to 2020 and the recession caused from the COVID-19 pandemic. All the countries of the sample maintain acceptable skewness values (between -2 and 2), with the exception of Spain, thus the data of each panel country can be considered normally distributed, except Spain, which demonstrates negatively skewed GDP growth rate data. Kurtosis has values between the range of -7 and 7 for all the examined countries, thus normality is confirmed.

**Table 10: FDI**

<b>COUNTRY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>MEAN</b>	<b>STD. DEVIATION</b>	<b>SKEWNESS</b>	<b>KURTOSIS</b>
<b>FRANCE</b>	0.2	3.88	2.0836 36	1.072822	0.072393	-1.10272
<b>GERMANY</b>	-0.73	12.73	2.565	2.501831	3.351393	8.402318
<b>ITALY</b>	-1.17	2.98	1.0854 55	0.952154	-0.09105	1.021926
<b>NETHERLANDS</b>	-37.68	86.48	18.213 64	26.48877	0.194059	1.510749
<b>POLAND</b>	0.15	6.23	3.4345 45	1.463504	0.106883	0.24843
<b>SPAIN</b>	0.64	6.77	3.1063 64	1.446591	0.830521	0.622152
<b>GENERAL SUMMARY</b>	<b>-37.68</b>	<b>86.48</b>	<b>5.0814 39</b>	<b>12.24001</b>	<b>2.940601</b>	<b>17.68661</b>





**Figure 10: FDI**

From Table 10 and Figure 10 it is obvious that the standard deviation demonstrates lower values than the mean for all the countries of the sample (with the exception of Germany

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and the Netherlands), implying a high dispersion of the data. Netherlands demonstrates the highest foreign direct investments, while the other countries of the sample have significantly lower values. All the countries of the sample maintain acceptable skewness values (between -2 and 2), with the exception of Germany, thus the data of each panel country can be considered normally distributed, except Germany, which demonstrates positively skewed FDI data. Kurtosis has values between the range of -7 and 7 for all the examined countries except Germany, thus normality is confirmed, with the exception of Germany, which demonstrates a peaked distribution.

## 4. Empirical analysis

### 4.1. Introduction

In the present chapter the proposed model which was described in the previous chapter is going to be applied and analyzed. The model that is going to be analyzed has the following form:

$$CIR_{it} = a_{it} + \beta_1 CNL_{it} + \beta_2 spread_{it} + \beta_3 efficiency_{it} + \beta_4 liquidity_{it} + \beta_5 size_{it} + \beta_6 CAR_{it} + \beta_7 GDP_{it} + \beta_8 FDI_{it} + \beta_9 IRV_{it} + \varepsilon_{i,t} \quad (9)$$

The variables have been described on the previous chapter. The model that is going to be examined consists of a dependent variable Y, a constant term and nine independent variables. The time period that is going to be examined spans from 2000 until 2021.

### 4.2. Unit root tests

The unit root test of Levin–Lin–Chu is going to be applied with the use of STATA statistical package in order to clarify whether the examined data are stationary or not. Stationarity is a requirement in order to proceed with the panel data analysis process. In the investigation process of trend-driven non-stationarity, the focus is given on the existence of a unit root for the characteristic function (associated with the autoregressive form process). According to the null hypothesis that the Levin-Lin-Chu test is going to test, all the panels contain a unit root, thus are stationary.

**Table 11: Unit root tests results**

Variable	p-value
<b>CIR</b>	0.3535
<b>CNL</b>	0.9987
<b>Spreads</b>	0.2174
<b>Liquidity</b>	0.8829

<b>CAR</b>	0.9924
<b>Size</b>	0.9759
<b>IRV</b>	0.0000
<b>Efficiency</b>	0.1018
<b>GDP growth rate</b>	0.0014
<b>FDI</b>	0.0850

According to the results of Table 11, only the variables IRV and GDP growth rate demonstrate stationarity (i.e. have a p-value lower than 5%). The other variables confirm the null hypothesis (stationarity), thus have to be transformed in order to be stationary. Their first differenced variables are going to be formulated in order to solve the non-stationarity issue.

**Table 12: First differenced variables of stationary initial variables**

<b>Variable</b>	<b>p-value</b>
<b>CIR</b>	0.0096
<b>CNL</b>	0.5997
<b>Spreads</b>	0.8205
<b>Liquidity</b>	0.2376
<b>CAR</b>	0.0005
<b>Size</b>	1.0000

<b>Efficiency</b>	<i>0.0001</i>
<b>FDI</b>	<i>0.0000</i>

According to the results of Table 12, only the variables CIR, CAR, Efficiency and FDI demonstrate stationarity (i.e. have a p-value lower than 5%). The other variables confirm the null hypothesis (stationarity), thus have to be transformed in order to be stationary. The first differenced variables of their natural logarithms are going to be formulated in order to solve the non-stationarity issue.

**Table 13: Unit root tests (first differences of natural logarithms)**

<b>Variable</b>	<b>p-value</b>
<b>CNL</b>	<i>0.0172</i>
<b>Spreads</b>	<i>0.0000</i>
<b>Liquidity</b>	<i>0.0064</i>
<b>Size</b>	<i>0.0100</i>

Values of Table 13 are lower than 5%, thus the variables are non-stationary.

### 4.3. Generalized Method of Moments (GMM) Estimation

The GMM estimators are going to be calculated with the STATA statistical package in order to identify relationships between the dependent and independent variables. The unknown parameters of the econometric model are going to be retrieved through this method. Under this procedure the specification of econometric models is possible while avoiding unwanted or unnecessary assumptions, such as specifying a particular distribution for the errors. The GMM estimator is obtained by minimizing the criterion function by making sample moment match the population moment.

The following results were retrieved:

**Table 14: GMM estimation results**

<b>CIR</b>	<b>Coefficient</b>	<b>Robust Std. Error</b>	<b>z</b>	<b>P&gt; z </b>	<b>[95% Conf. Interval]</b>
<b>CNL</b>	0.9759793	0.3913452	2.49	0.013	0.340631 - 0.6702298
<b>Spread</b>	0.165389	0.1142658	1.45	0.148	- 0.0543512 - 0.2555624
<b>Liquidity</b>	-0.3836752	0.2982184	-1.29	0.198	- 0.9465828 - 0.1089443
<b>CAR</b>	-0.0220273	0.0787316	-0.28	0.780	-.0427848 - 0.1516417
<b>Size</b>	1.746007	1.865709	0.94	0.349	-1.56939 - 12.26399
<b>IRV</b>	-0.4377997	0.274948	-1.59	0.111	- 0.8973372 - 0.2392094
<b>GEI</b>	0.9194741	0.7551169	1.22	0.223	- 0.6681967 2.74875

<b>GDP growth rate</b>	-0.0761347	0.0273428	-2.78	0.005	- 0.0000109 - 0.0000393
<b>FDI</b>	0.0136507	0.0013026	10.48	0.000	0.0091099 - 0.0174912

According to the results of Table 14, the variables of CNL (carbon neutral lending), GDP growth rate and FDI (foreign direct investments) seems to influence credit risk on a 1% significance level, since demonstrating p-values <0.01. Thus, they should be incorporated in relevant models. According to the estimated coefficients, both CNL and FDI seem to demonstrate a positive relationship with CIR (credit risk). In other words, an increase of CNL or FDI increases credit risk. On the other hand, GDP growth rate demonstrates a negative relationship with CIR. Thus, an increase of the GDP growth rate decreases credit risk (as measured by CIR).

#### 4.4. Granger causality test

Granger causality test indicates the direction of causality. It also helps to identify which variable acts as a determining factor for another variable. Granger causality implies a correlation between the current values of one variable and the past values of other variables. For example, consider two variables X and Y. If lagged values of X and Y can predict X, then Y will Granger-cause X. Conversely, if X influences Y, then X Granger-causes Y. This is called unidirectional causality because one variable Granger-causes another variable. In some cases, both variables X and Y are found to be influenced by the other's lagged values in addition to its own. This leads to a bidirectional causality. For the purposes of the present study, it was examined whether CIR (credit risk) is caused by everyone of the independent variables. The estimated results for the examined data are presented on Table 15.

**Table 15: Granger causality test results**

Independent variable	Z-bar p-value	Z-bar tilde p-value
<b>CNL</b>	0.0013	0.0153

<b>Spread</b>	0.0000	<i>0.0001</i>
<b>Liquidity</b>	0.0585	0.1766
<b>CAR</b>	0.0000	<i>0.0000</i>
<b>Size</b>	0.0000	<i>0.0000</i>
<b>IRV</b>	0.0192	0.0864
<b>GEI</b>	0.9632	0.8907
<b>GDP growth rate</b>	0.7030	0.6297
<b>FDI</b>	0.2635	0.2816

According to the results of the Granger causality test, CNL is again found to (Granger) cause credit risk. Furthermore, the variables of bank spreads, CAR, and banking system size were also found to (Granger) cause credit risk on the 5% significance level, since demonstrating p-values <0.05.

#### 4.5. Results interpretation

According to the results of the present study, a relationship between credit risk and carbon neutral lending (which functioned as a measure of environmental risk) was identified. Thus, environmental risk has to be integrated to the risk estimation models of banking institutions. This finding comes in accordance to the findings of other relevant studies (Weber, 2011, Weber et al., 2006, Bauer & Hann, 2010). Financial institutions have to integrate environmental risk to their overall risk assessment and management procedures. The extent to which such an action occurs for the case of European banks (which form the field of interest of the present study) has to be examined on future research. According to a relevant study that was conducted on the past (Weber et al., 2006), European banks integrated environmental risk into the rating phase, but not in all phases of the credit management process, except banking institutions that had signed the UNEP statement on the environment and sustainable development. Therefore, a future study could examine whether this situation has now been overturned.

The GDP growth rate represents the economic cycle fluctuation, which according to the relevant literature has a strong influence on credit risk (Koju et al., 2019). Thus, the finding of a negative relationship between this indicator and credit risk comes as expected, since during periods of high financial growth credit risk tends to be decreased, while increasing during financial recession. On the other hand, the relationship between



FDI and credit risk needs further study. Banking spreads and CAR are related to credit risk, since a higher spread and capital adequacy ratio results to a more stable bank, that has the necessary funds for its operations. Finally, the causal relationship identified between banking sector size and credit risk was also expected, since a larger banking sector is riskier and creates more systemic risk when its capital is lower and its funding is not stable (Laeven et al., 2014). Thus, this finding functions as a prompt to examine the capital structure of European banks.

## Conclusion

The sustainability of the banking system is one of the most significant problems of a country's economy, since an unstable banking system generates many problems in a country's economic and social situation. A troubled banking system causes significant barriers towards the achievement of economic development in the countries in which it occurs. Thus, significant interest has been paid in order to predict credit risk, so that banks who intend to finance the economy and investments of enterprises and organizations, would be able to make the most proper decisions in order to safeguard their sustainability, and get their funds back so that they don't have a problem due to a lack of liquidity.

The purpose of the present thesis was to identify an econometric model, which after tests (which were carried out on a sample of the six largest economies of the E.U.), could predict the statistically significant variables for the estimation of the credit risk, with a particular focus on environmental risk for the case of the European banking system. The six largest economies of the E.U. were selected for the sample, with their size, industry size (as a main source of CO<sub>2</sub> emissions), and de-carbonization efforts as the main criteria for their inclusion. The examined period spanned between 2000 and 2021, since the issues of green financing, environmental sustainability, environmental risk and CO<sub>2</sub> emissions reduction came to the forefront during these years.

The available data were used in order to identify whether the variables that were included in the applied econometric model could demonstrate a strong relationship with credit risk. Such a relationship would imply that these variables can be used to better predict credit risk. By applying GMM estimation and Granger causality test to the proposed model, it was identified that six variables, out of nine that were examined, were statistically

significant and can contribute to the prediction of credit risk. Environmental risk (as measured by green lending – CO<sub>2</sub> reduction lending) was found to be one of the identified variables. This finding indicates that it should be integrated to the estimation of credit risk.

The main independent variable that was examined was CNL (carbon neutral lending), which is the ratio of low carbon emissions lending to the total amount of loans and functions as a measurement of the environmental risk. It was found to demonstrate a relationship and influencing credit risk both through the GMM estimators and Granger causality test, under a positive relationship, that is, with an increase in the number of carbon neutral loans, the credit risk also increases. A possible explanation about this finding is that the transition towards carbon neutrality requires significant time periods in order to provide benefit, while large amounts are needed in order to finance such projects. Furthermore, the companies that receive such funding also undertake significant risk related to the success of such projects. This issue needs further investigation, in order to identify the manner through which risk is affected from green funding, as well as the risk that companies that conduct carbon neutral investments receive.

The independent variable of GDP growth rate demonstrated a statistically significant and negative relationship with credit risk according to the GMM estimators, in other words an increase of the GDP growth rate generates a reduction in credit risk. During periods of financial growth, financial risk decreases, while increasing during periods of financial recession.

As for the independent variable FDI which demonstrates the foreign direct investments to an economy, this variable statistically significantly affects the credit risk according to the GMM estimates under a positive manner. There is not relevant evidence according to the literature, thus further study has to be conducted in order to examine the identified relationship.

Regarding the causal relationships between credit risk and banking spreads (which provide the difference between a bank's income and expense due to interests) and between credit risk and CAR (which provides the capital adequacy of banks), they were also expected, since a higher spread and capital adequacy ratio results to a more stable bank, that has the necessary funds for its operations. Finally, the causal relationship identified between banking sector size and credit risk was also expected, since a larger banking sector is riskier and creates more systemic risk when its capital is lower and its funding is not stable (Laeven et al., 2014). Thus, this finding functions as a prompt to examine the capital structure of European banks.

The proposed model is relatively simple and can be applied very easily. Therefore, the model could be generalized and applied to other countries outside the sample. The

significance of incorporating environmental risk to the estimation of credit risk was documented in practice.

The specific econometric model that was built and applied needs further research outside of the thesis. It should also be applied to a sample with countries outside the E.U., so that the ability of the model to accurately predict credit risk can be tested. Furthermore, it would be applied to specific banks. Another aspect is to apply the proposed model to a specific industry in relation to its transition towards carbon neutrality and the relevant funding from banking institutions, because in general the economic behavior of enterprises is greatly influenced by the product that is produced. To test its adequacy, it should be applied to other economic conditions and other economic environments besides the E.U. to obtain a broader picture as far as its application as a credit risk predictive tool is concerned.

Different econometric methods and tests can be applied in order to assess if the same conclusions as the present study are drawn.

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